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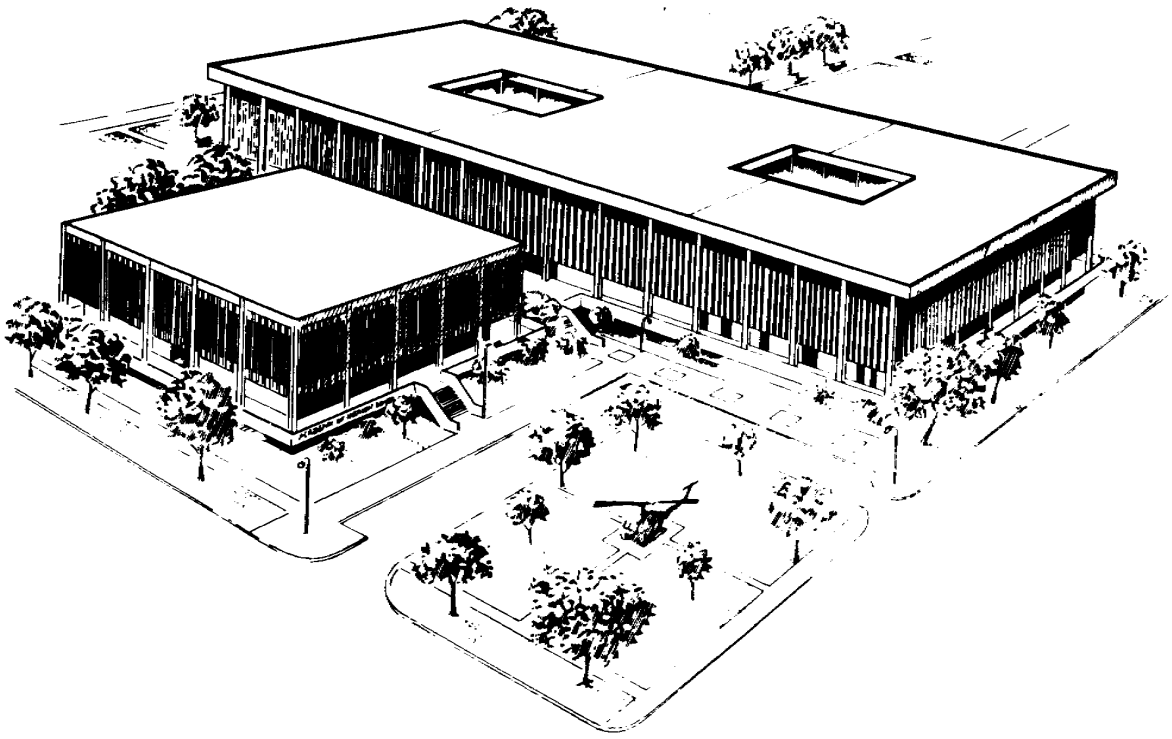
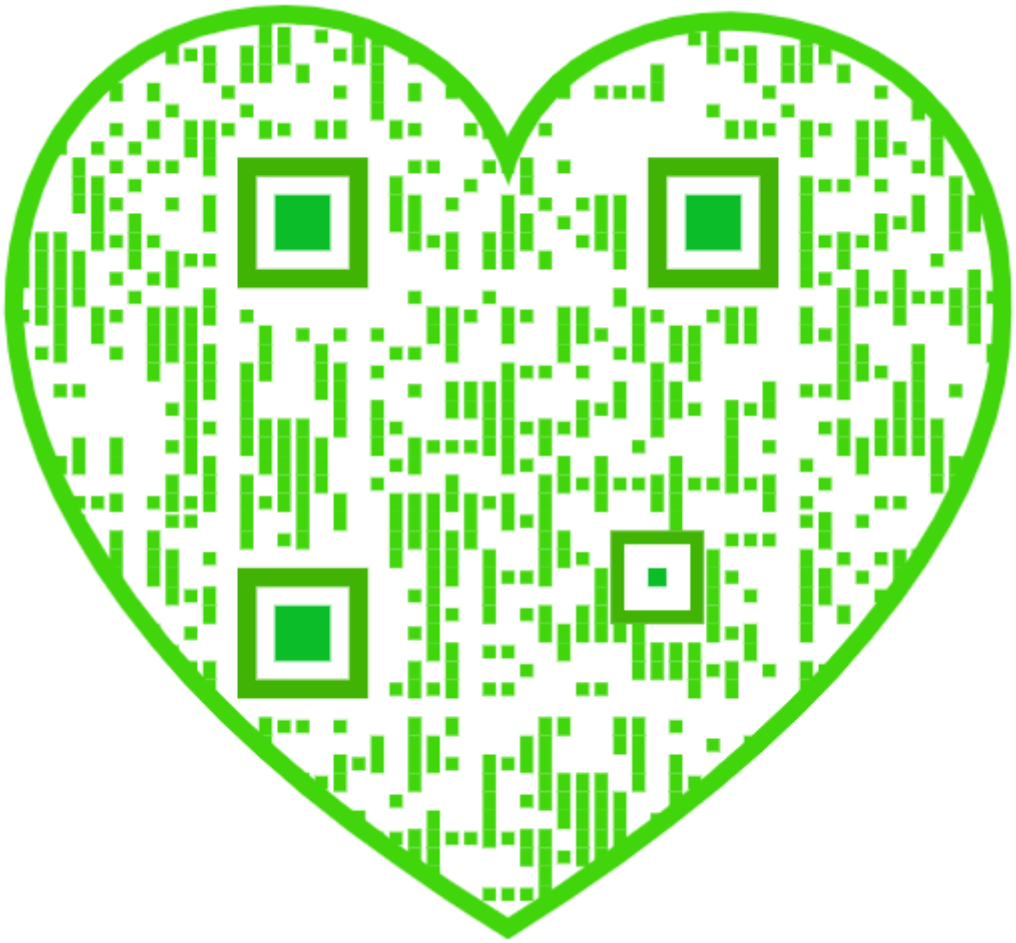


# PARASITOLOGY II

## SUBCOURSE MD0842 EDITION 100



## DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

## ADMINISTRATION

Students who desire credit hours for this correspondence subcourse must enroll in the subcourse. Application for enrollment should be made at the Internet website: http://www.atrrs.army.mil. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application; then follow the on-screen instructions.

For comments or questions regarding enrollment, student records, or examination shipments, contact the Nonresident Instruction Branch at DSN 471-5877, commercial (210) 221-5877, toll-free 1-800-344-2380; fax: 210-221-4012 or DSN 471-4012, e-mail accp@amedd.army.mil, or write to:

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## CLARIFICATION OF TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" 'are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

## USE OF PROPRIETARY NAMES

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**CORRESPONDENCE COURSE OF**
**THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL**

**SUBCOURSE MD0842**

# PARASITOLOGY II

## INTRODUCTION

The focus of this subcourse is the identification forms and life cycles of parasites which infect humans. Organisms which will be discussed include parasitic members of Phylum Protozoo, Platyhelminthes, Aschelminthes, and Acanthocephahelminthes. You will be provided with descriptions of the general characteristics of the phylum and detailed illustrations of the cycle forms of significant members of the phylum.

This subcourse is the second of two subcourses which discuss parasitology. In Parasitology I, an overview of parasitology and information for the collection, preservation, and processing of clinical specimens were presented. The material provided in this subcourse will build on that information. It contains information that will help you gain knowledge and skill in the identification of human parasites. It does not attempt to cover parasitology in depth but is only intended to guide you toward becoming competent in the field. For your further learning a bibliography of supplemental sources of parasitology information is included in Appendix B.

**Subcourse Components**:

The subcourse instructional material consists of four lessons and three appendixes as follows:

Lesson 1, Phylum Protozoo; Rhizopoda and Zoomastigophora.
Lesson 2, Phylum Protozoo; Ciliata, Piroplasmasida and, Sporozoa.
Lesson 3, Phylum Platyhelminthes.
Lesson 4, Phylum Aschelminthes; Phylum Acanthocephahelminthes; Arthropods and Vectors.
Appendix A, Clinical Manifestations and Treatment of the Common Parasitic Diseases.
Appendix B, References
Appendix C, Medical Parasitology

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

**Credit Awarded**:

Upon successful completion of the examination for this subcourse, you will be awarded 12 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

## LESSON ASSIGNMENT

| | |
|---|---|
| **LESSON 1** | Phylum Protozoo; Rhizopoda and Zoomastigophora. |
| **LESSON ASSIGNMENT** | Paragraphs 1-1 through 1-11. |
| **LESSON OBJECTIVES** | After completing this lesson, you should be able to: |

1-1. Identify the general characteristics of Protozoans.

1-2. Identify the organism characteristics of parasitic members of Class Rhizopoda.

1-3. Select a statement that best describes the life cycle of a member of Class Rhizopoda.

1-4. Identify the organism characteristics of parasitic members of Class Zoomastigophora.

1-5. Select a statement that best describes the life cycle of a member of Class Zoomastigophora.

1-6. Identify the specimen of choice for recovery of specific protozoan organisms.

1-7. Identify the special technique required for recovery of specific protozoan organisms.

**SUGGESTION** After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

# LESSON 1

# PHYLUM PROTOZOO: RHIZOPODA AND ZOOMASTIGOPHORA

## Section I. OVERVIEW OF PROTOZOO

### 1-1. GENERAL COMMENTS

Protozoans are unicellular (one-celled) organisms which belong to the subkingdom Eucaryota. They vary in size from almost submicroscopic to 120 micrometers (mcm) in diameter. Each protozoan is a complete organism capable of carrying out the same physiological functions performed by many cells in a more complex organism. There are specialized and complex organelles found in protozoans which perform the functions of locomotion, metabolism, and reproduction. It has been suggested that instead of unicellular, the protozoan organisms should be termed acellular because of the intricacy of their functions and also because some of these organisms have more than one nuclei. The members of this phylum which are parasitic to humans, while preserving the general characteristics of their free living counterparts, are capable of survival in the adverse system of the host.

### 1-2. HISTORY

Some protozoans are beneficial to mankind by being part of the food chain and by serving as experimental subjects. Others have adapted well to a parasitic existence causing many diseases in humans. Much has been discovered about protozoans since Anton van Leeuwenhoek first saw the cysts of Giardia lamblia from his own stool and reported them to the Royal Academy in his treatise "Wee besties." His discoveries occurred in the late 1600's.

### 1-3. STRUCTURE

The various forms and functions of protozoan cells are truly amazing for what we consider as simple single-celled organisms. Whether they are amoeba, flagellates, or ciliates, they contain ultramicroscopic organelles that enable them to perform many of the activities observed in higher animals. However, the most easily recognized and identifiable structure within the protozoan cell is the nucleus. Nuclei among the protozoa usually are of two types, the vesicular nucleus with a clearly defined internal space, and the compact nucleus which appears to be a solid mass. Most of the protozoa which parasitize humans exhibit the vesicular type. Because nuclear chromatin components can be stained and easily observed within the vesicular nucleus, the arrangement of the chromatin, whether dispersed or condensed, is helpful in differentiation of the species within certain classes of the Protozoo. See figures 1-1 and 1-2.

## 1-4. PARASITIC PROTOZOO

Within the phylum Protozoo, there are five classes which contain organisms parasitic to man. The classes are: Rhizopoda, Zoomastigophorai Ciliata, Piroplasmasida, and Sporozoa. The identification forms and life cycles of Rhizopoda and Zoomastigophora will be described in this lesson. Ciliata, Piroplasmasida, and Sporozoa will be described in Lesson 2.

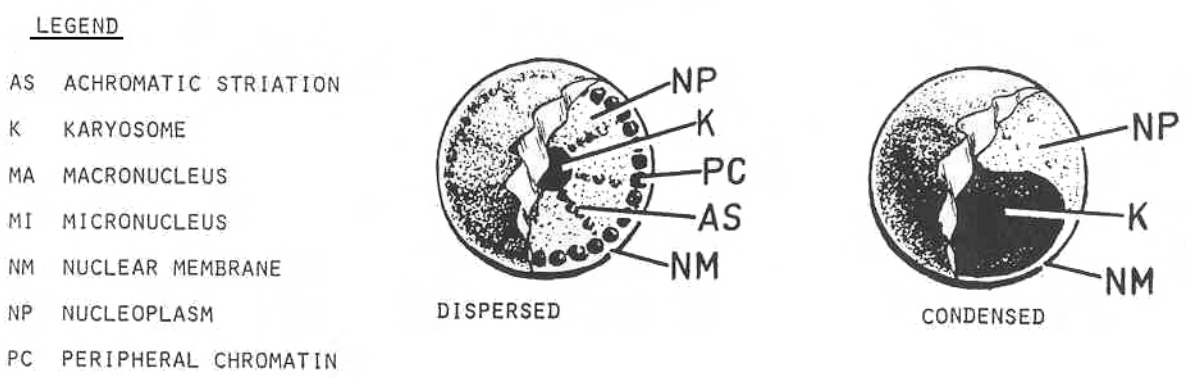



Figure 1-1. Vesicular nucleus.

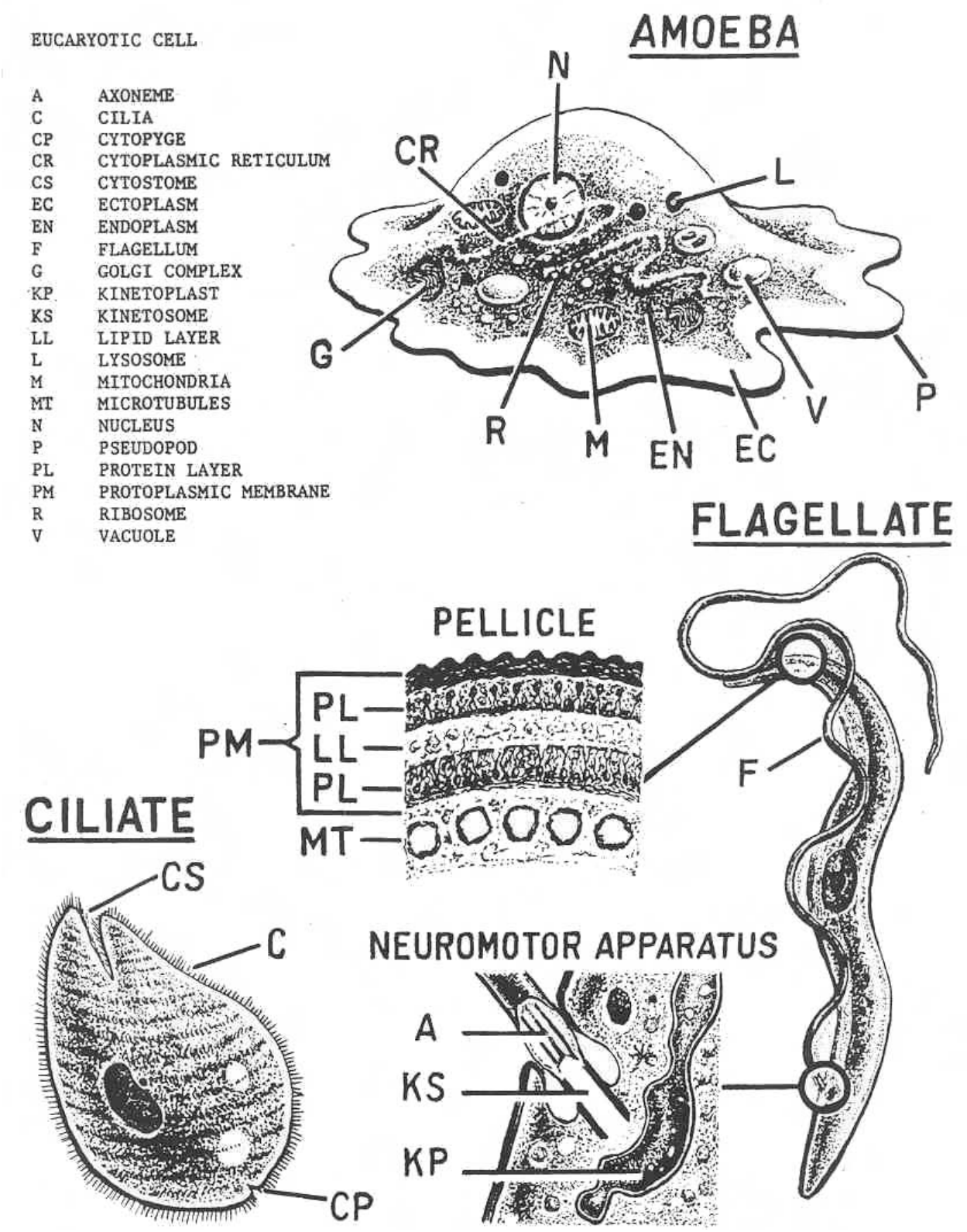



Figure 1-2. Typical protozoan organisms.

## Section II. CLASS RHIZOPODA

### 1-5. GENERAL DESCRIPTION

Members of this class include protozoans which use pseudopodia (false feet) for locomotion. There are many species of this class that are free living and therefore will not be discussed here. The attention is focused instead on those organisms which are parasites of man. There are six genera recognized as human parasites. These include the pathogens: Entamoeba histolytica and Naegleria fowleri, and some species of the genera AcanthamoTba and Hartmanella, as well as commensal organisms from the genera: Entamoeba, Endolimax, and Iodamoeba. One commensal amoeba, Entamoeba gingivalis, is found in the mouth of mammals.

### 1-6. LOCOMOTION AND DIGESTION

Locomotion and ingestion are accomplished by the use of the pseudopodia. Once the food substance is contained within the cell, the organism goes through the processes of enzymatically breaking down and absorbing the nutrients. Egestion of unused residue is performed by the expulsion of the vacuole out of the cell.

### 1-7. RESPIRATION AND REPRODUCTION

Respiration is performed by simple absorption of dissolved oxygen from the liquid environment. Excretion of gases and waste is performed by diffusion out of the organism through the cell membrane. Liquid regulation inside the body is controlled by contractile vacuoles which serve as two-way pumps that control the hydrostasis between the organism and the environment. These organisms reproduce through asexual reproduction consisting of simple cell division.

### 1-8. AMOEBIC STATES

The amoebic organisms exist in two states. The vegetative state is called the trophozoite. This is the metabolic stage of the protozoan which is very sensitive to the changes of the environment. As unfavorable conditions set in, the organisms go through a process called encystation. The cyst is the resistant state or stage of the amoebic organisms. Excystation takes place with the return of favorable conditions. Some species in this class also use the encystation process for the purpose of reproduction. In this case one cyst yields more than one organism. See figure 1-3.

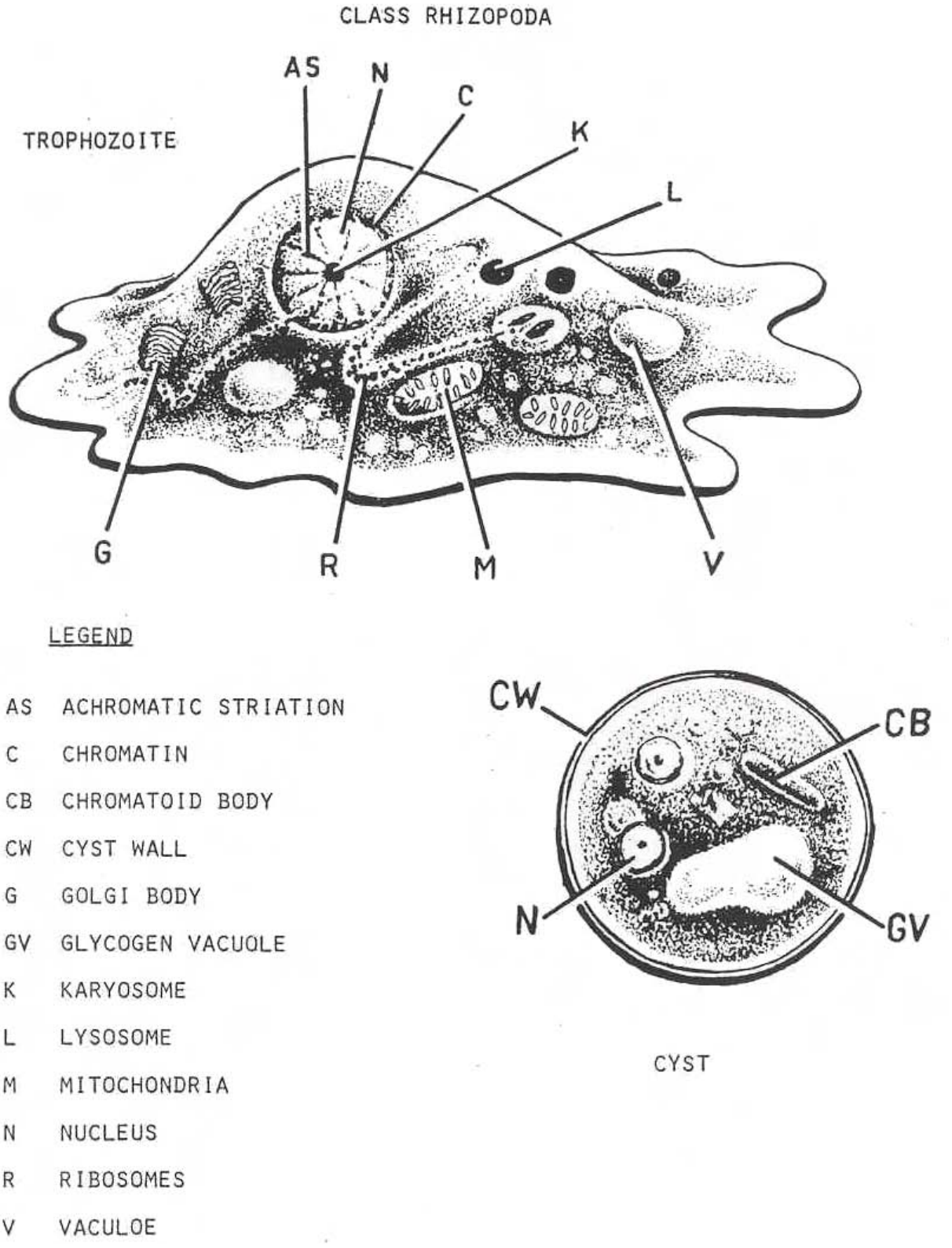



Figure 1-3. Rhizopadan stages.

## ORGANISM 1 -- Entamoeba histolytica

### GENERAL CHARACTERISTICS

COMMON NAME: Montezuma's revenge.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan prevalent in the tropics and subtropics.
PATHOGENESIS: Pathogenic.
HABITAT
Primary Site: Intestional Mucosa (colon).
Secondary Site: Liver, lungs, brain.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Other mamalls.
INFECTED FORM: Mature quadrinucleated cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

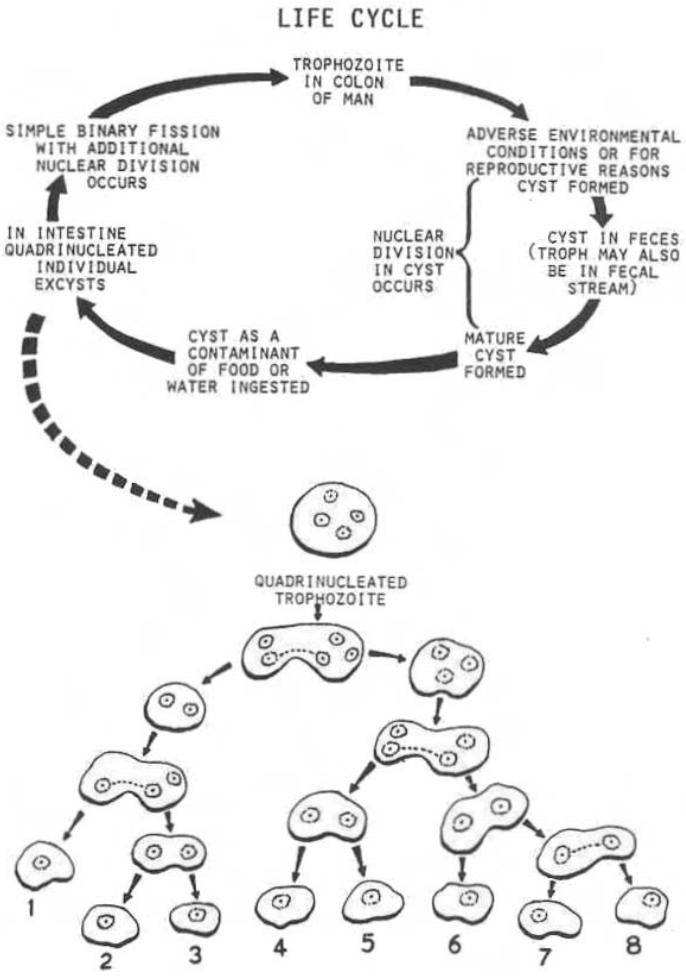
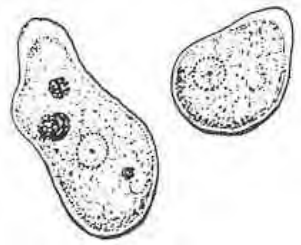



Figure 1-4. Life cycle of Entamoeba histolytica.

**Entamoeba histolytica** (cont)

TROPHOZOITE

SIZE: 11 to 60 mcm.
SHAPE : Irregular.
NUCLEUS: Vesicular, dispersed.
NUMBER: One.
PERIPHERAL CHROMATIN: Finely granular and evenly distributed.
KARYOSOME: Small, discrete, and usually centrally located.
NUCUEOPLASM Clean.
CYTOPLASM: Clean.
APPEARANCE: Finely granular.
INCLUSIONS: Occasional RBCs.
MOBILITY: Directional and progressive with finger-like pseudopodia.



CYST

SIZE: 11 to 20 mcm.
SHAPE : Spherical.
NUCLEUS:
NUMBER: One to four; the mature cyst has four.
PERIPHERAL CHROMATIN: Finely granular and evenly distributed.
KARYOSOME: Small, discrete, and usually centrally located.
NUCUEOPLASM Clean.
CYTOPLASM: Finely granular.
CHROMATOID BODIES: If present, cigar-shaped, rounded ends; diagnostic feature.
GLYCOGEN: Diffused, in vacuoles for young cysts.

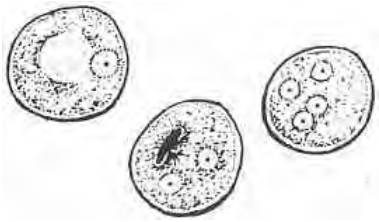


Figure 1-5. Stages of E. histolytica.

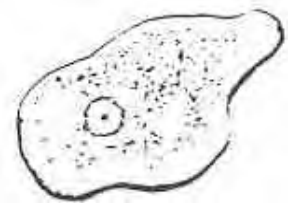
## ORGANISM 2 -- Entamoeba hartmanii

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic.
LABORATORY IDENTIFICATION: Morphologically identical to E. histolytica except for the size and inclusions in the trophozoite.
SPECIMEN SOURCE: Feces.

THOPHOZOITE

SIZE: 5 to 10 mcm.
INCLUSIONS: Bacteria.



CYST

SIZE: 5 to 8 mcm.

Figure 1-6. Entamoeba hartmanii

## ORGANISM 3 -- Entamoeba coli

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic, often confused with E. histolytica.
HABITAT: Large intestine (colon).
INTERMEDIATE HOST: None.
RESERVOIR HOST: Primates.
INFECTED FORM: Mature cyst with eight nuclei.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

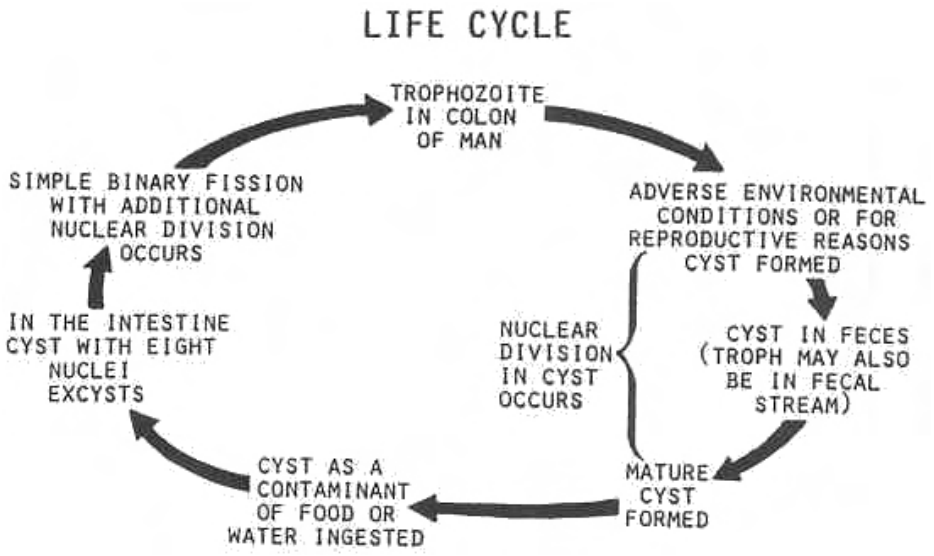

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS OR FOR REPRODUCTIVE REASONS CYST FORMED
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
NUCLEAR DIVISION IN CYST OCCURS
MATURE CYST FORMED
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE CYST WITH EIGHT NUCLEI EXCYSTS
SIMPLE BINARY FISSION WITH ADDITIONAL NUCLEAR DIVISION OCCURS

Figure 1-7. Life cycle of Entamoeba coli.

TROPHOZOITE

SIZE: 10 to 50 mcm.
SHAPE : Irregular.
NUCLEUS: Vesicular, dispersed.
NUMBER: One.
PERIPHERAL CHROMATIN: Course granules; irregular size and distribution
KARYOSOME: Small but larger than e. histolytica and usually eccentric.
NUCUEOPLASM: Not as clean as E. histolytica.
CYTOPLASM:
APPEARANCE: Dirty, vaculoated, coarsely granular.
INCLUSIONS: Yeasts, molds, bacteria.
MOBILITY: Nondirectional with blunt pseudopodia.

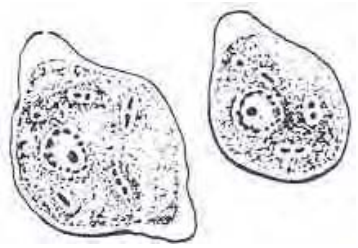


Figure 1-8. Trophozoites, E. coli.

CYST

SIZE: 10 to 35 mcm.
SHAPE : Spherical.
NUCLEUS: Vesicular, dispersed.
NUMBER: 1-8; mature cyst has 8.
PERIPHERAL CHROMATIN: Course granules; irregular size and distribution
KARYOSOME: Small but larger than e. histolytica and usually eccentric.
NUCUEOPLASM: Not as clean as E. histolytica.
CYTOPLASM: Dirty.
CHROMATOID BODIES: Splintered-ends; uneven; pointed ends; resembles shock of wheat.
GLYCOGEN: Diffused.

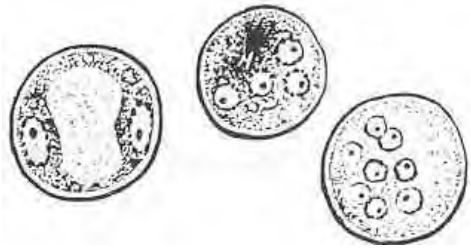


Figure 1-9. Cysts, E. Coli.

## ORGANISM 4 -- Entamoeba polecki

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Papua, New Guinea.
PATHOGENESIS: Occasional parasite of man.
HABITAT: Intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Pigs and monkeys.
INFECTED FORM: Mature, uninucleated cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

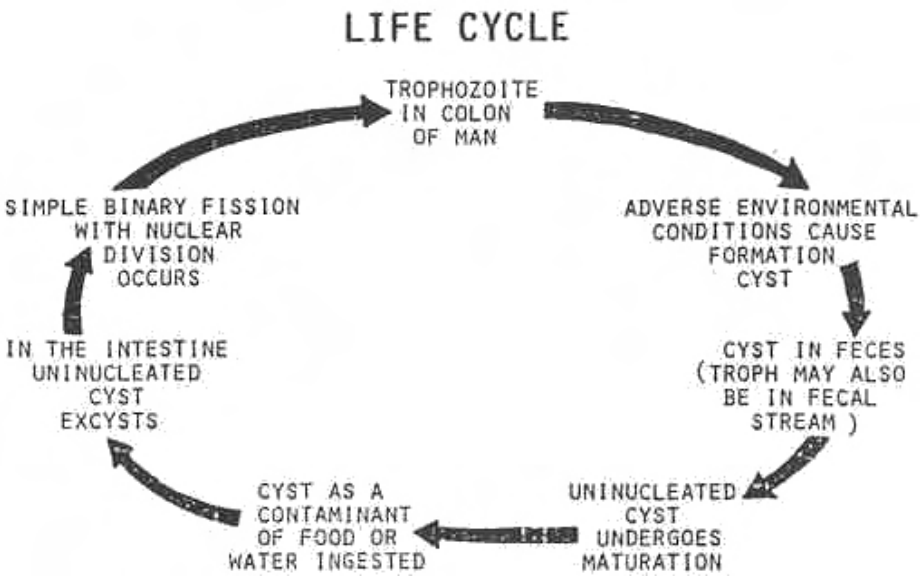

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE FORMATION CYST
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM )
UNINUCLEATED CYST UNDERGOES MATURATION
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE UNINUCLEATED CYST EXCYSTS
SIMPLE BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 1-10. Life cycle of Entamoeba polecki.

TROPHOZOITE

SIZE: 10 to 25 mcm.
SHAPE : Irregular.
NUCLEUS: Vesicular, dispersed.
NUMBER: One.
PERIPHERAL CHROMATIN: Fine and course granules; may be even or uneven; could be masses at one end.
KARYOSOME: Small; discrete; usually eccentric; may be fragmented.
NUCUEOPLASM: Usually dirty.
CYTOPLASM:
APPEARANCE: Very dirty and vaculoated.
INCLUSIONS: Bacteria.
MOBILITY: Nondirectional (occasionally directional).

**Entamoeba polecki (cont)**

Figure 1-11. Trophozoite, E. polecki.

CYST

SIZE: 9 to 18 mcm.
SHAPE : Spherical to oval.
NUCLEUS: Vesicular, dispersed.
NUMBER: One.
PERIPHERAL CHROMATIN: Fine and course granules; may be even or uneven; could be masses at one end.
KARYOSOME: Small; discrete; usually eccentric; may be fragmented.
NUCUEOPLASM: Usually dirty.
CYTOPLASM:
CHROMATOID BODIES: Many; irregular shape with pointed ends..
GLYCOGEN: Diffused.
INCLUSION MASS: Unknown nature but typical of the oranism.

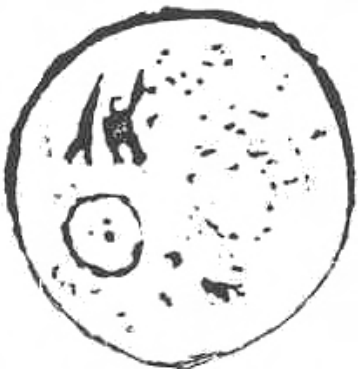


Figure 1-12. Cyst, E. polecki.

## ORGANISM 5 -- Naegleria fowleri

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Australia, Europe, and America.
PATHOGENESIS: Primary amebic meningoencepha (PAM).
HABITAT: Usually free living; the meninges in man.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None known.
INFECTED FORM: Biflagellated trophozoite.
MODE OF INFECTION: Active penetration through the nostrils.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Cerebral spinal fluid.

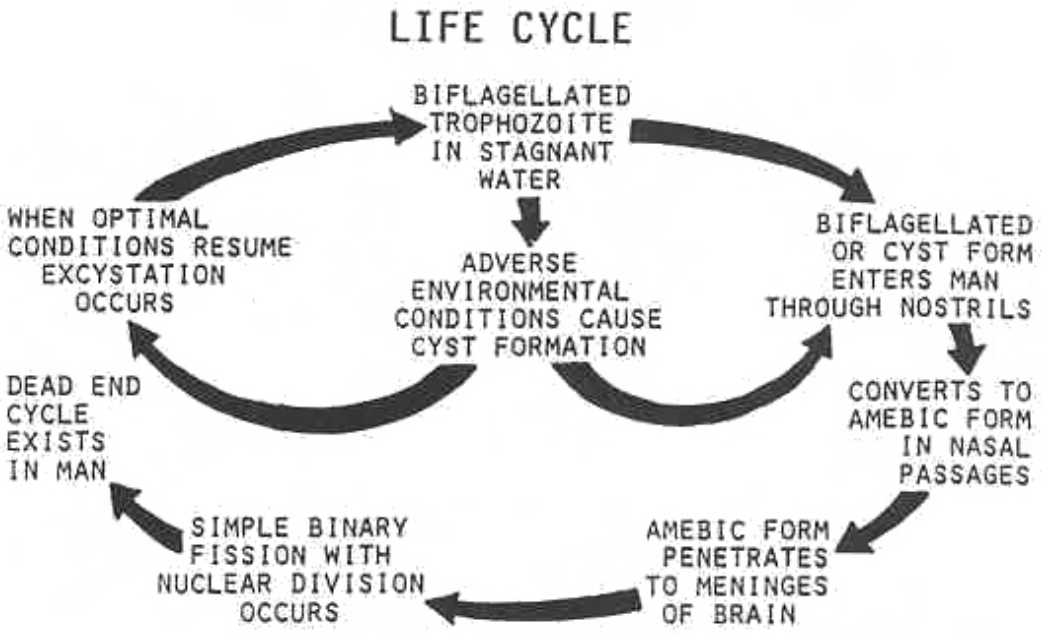
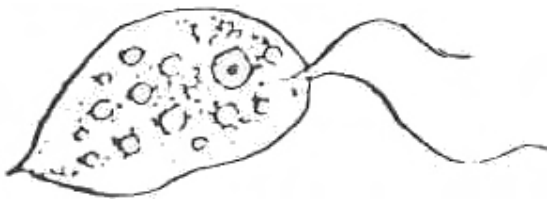

LIFE CYCLE
BIFLAGELLATED TROPHOZOITE IN STAGNANT WATER
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE CYST FORMATION
WHEN OPTIMAL CONDITIONS RESUME EXCYSTATION OCCURS
BIFLAGELLATED OR CYST FORM ENTERS MAN THROUGH NOSTRILS
CONVERTS TO AMEBIC FORM IN NASAL PASSAGES
AMEBIC FORM PENETRATES TO MENINGES OF BRAIN
SIMPLE BINARY FISSION WITH NUCLEAR DIVISION OCCURS
DEAD END CYCLE EXISTS IN MAN

Figure 1-13. Life cycle of Naegleria fowleri.

**Naegleria fowleri (continued)**

FREE-LIVING TROPHOZOITE

Indistinguishable from N. gruberi, a free living organism isolated from soil.
SHAPE: Pear shape.
FLAGELLA--ANTERIOR: 2 to 4.



AMOEBIC TROPHOZOITE

SIZE: 10 to 25 mcm.
SHAPE : Elongated to oval,
NUCLEUS: Vesicular, dispersed.
NUMBER: One.
PERIPHERAL CHROMATIN: Finely granular and evenly distributed.
KARYOSOME: Some small but larger than E. histolytica.
NUCUEOPLASM: Clean to dirty.
CYTOPLASM:
APPEARANCE: Finely granular.
INCLUSIONS: Cellular debris.
MOBILITY: Nondirectional and sluggish.

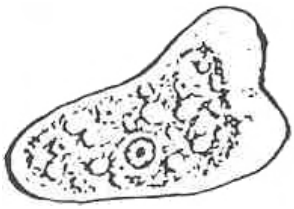


Figure 1-14. Stages of N. fowleri. (cont)

CYST

SIZE: 8 to 12 mcm.
SHAPE : Oval to spherical.
NUCLEUS: Vesicular, dispersed.
NUMBER: One.
PERIPHERAL CHROMATIN: Finely granular and evenly distributed.
KARYOSOME: Some small but larger than E. histolytica.
NUCUEOPLASM: Clean to dirty.
CYTOPLASM:
CHROMATOID BODIES: None detected.
GLYCOGEN: Diffuse

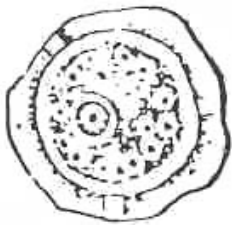


Figure 1-14. Stages of N. fowleri. (concluded)

## Hartmanella and Acanthamoeba species

### GENERAL CHARACTERISTICS

Pathogenesis--(mild disease process). At one time, the disease caused by N. fowleri was thought to be caused by these two genera. At present, it is believed that there is no pathogenicity caused by Hartmanella species, but Acanthamoeba species are still believed to produce infection in man.

Laboratory identification--same as N. fowleri except for the absence of the flagellated stage.

## ORGANISM 6 -- Ensolimax nana

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic.
HABITAT: Intestines (colon).
INTERMEDIATE HOST: None.
RESERVOIR HOST: None.
INFECTED FORM: Mature, quadrinucleated cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

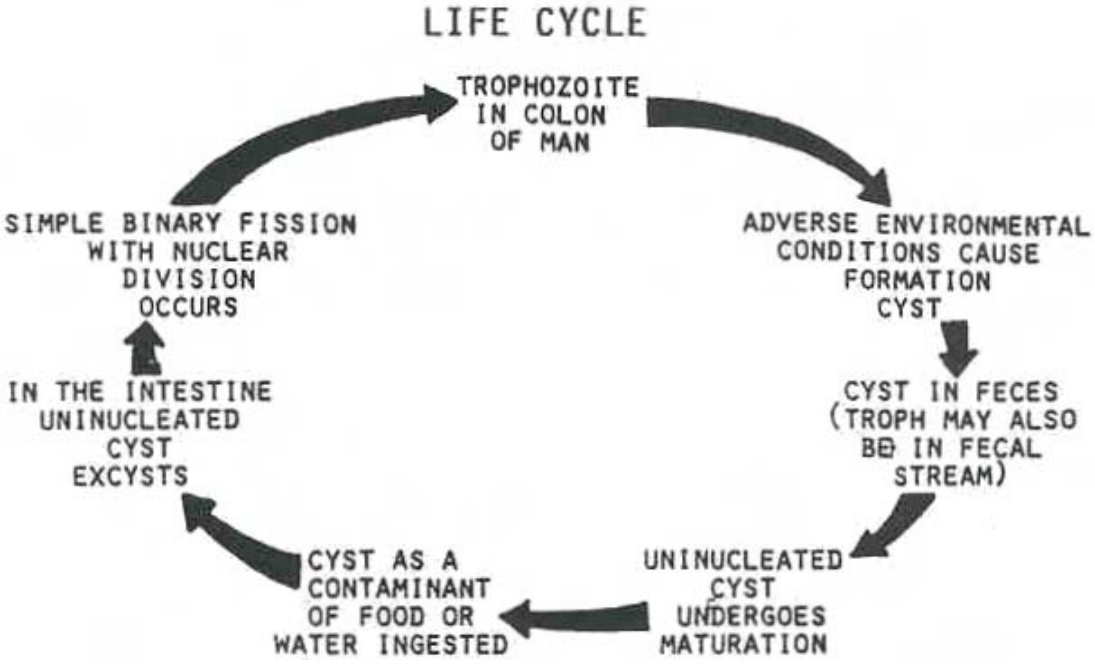
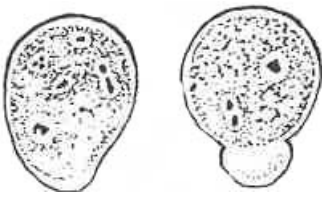

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE FORMATION CYST
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
UNINUCLEATED CYST UNDERGOES MATURATION
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE UNINUCLEATED CYST EXCYSTS
SIMPLE BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 1-15. Life cycle of Endolimax nana.

## Ensolimax nana (continued)

TROPHOZOITE

SIZE: 6 to12 mcm.
SHAPE : Irregular to oval,
NUCLEUS: Vesicular, condenced.
NUMBER: One.
PERIPHERAL CHROMATIN: Absent.
KARYOSOME: Large; irregular; usually centrally located than E. histolytica.
NUCUEOPLASM: Relatively clean but dirtier then E. histolytica.
CYTOPLASM:
APPEARANCE: Relatively clean but dirtier then E. histolytica.
INCLUSIONS: Bacteria.
MOBILITY: Nondirectional with blunt pseudopodia.



CYST

SIZE: 5 to 10mcm.
SHAPE : Oval to elliptical.
NUCLEUS: Smaller than the trophozoite.
NUMBER: One to four.
PERIPHERAL CHROMATIN: Absent.
KARYOSOME: Large; irregular; usually centrally located than E. histolytica.
NUCUEOPLASM: Relatively clean but dirtier then E. histolytica.
CYTOPLASM:
CHROMATOID BODIES: Rarely present as granules.
GLYCOGEN: Usually diffused.

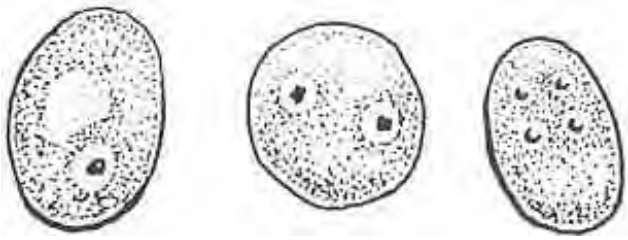


Figure 1-16. Stages of E. nana.

## ORGANISM 7 -- Iodamoeba butschlii

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic; considered to be a possible pathogen in severe physical stress (malnutrition).
HABITAT: Large intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Pigs.
INFECTED FORM: Mature, uninucleated cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

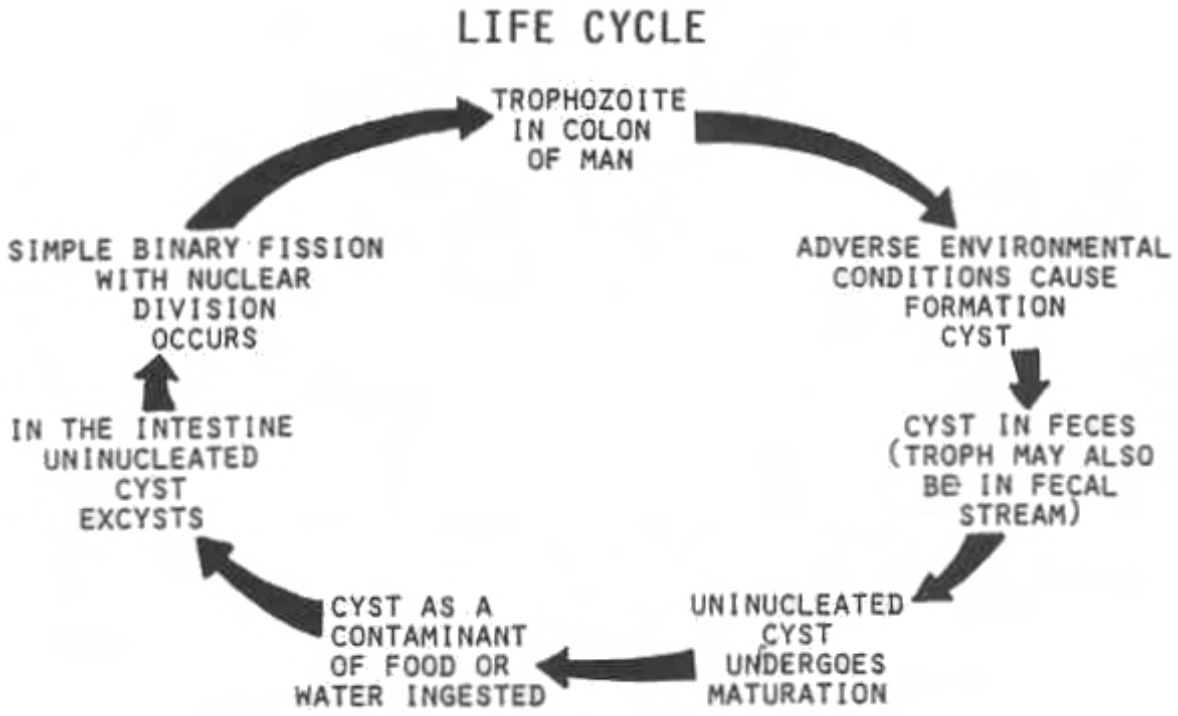

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE FORMATION CYST
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
UNINUCLEATED CYST UNDERGOES MATURATION
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE UNINUCLEATED CYST EXCYSTS
SIMPLE BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 1-17. Life cycle of Iodamoeba butschlii.

## Iodamoeba butschlii (continued)

TROPHOZOITE

SIZE: 8 to20 mcm.
SHAPE : Irregular to round; most oval.
NUCLEUS: Vesicular, condensed.
NUMBER: One.
PERIPHERAL CHROMATIN: Absent; achromatic granules surrounding the karyosome.
KARYOSOME: Large and eccentric due to achromatic granules.
NUCUEOPLASM: Dirty.
CYTOPLASM:
APPEARANCE: Coarse; very dirty.
INCLUSIONS: Bacteria, molds and yeasts
MOBILITY: Nondirectional with blunt pseudopodia.

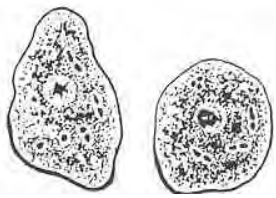


Figure 1-18. Trophozoiet, I. butschlii.

CYST

SIZE: 5 to 20mcm.
SHAPE : Irregular; most are oval.
NUMBER: One.
PERIPHERAL CHROMATIN: Absent; achromatic granules surrounding the karyosome.
KARYOSOME: Large and eccentric due to achromatic granules.
NUCUEOPLASM: Dirty.
CYTOPLASM:
CHROMATOID BODIES: None seen.
GLYCOGEN: Discrete; compact; well defined; large mass (vacuole).

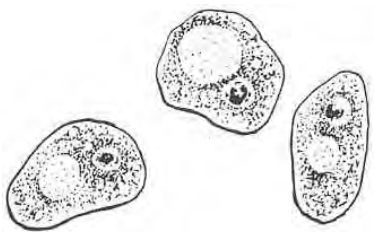


Figure 1-19. Cyst, I. butschlii.

## Section III CLASS ZOOMASTIGOPHORA

### 1-9. GENERAL DESCRIPTION

These organisms move by means of rotation of a whiplike organelle called a flagellum (plural: flagella). The flagella can also be used for gathering and sorting food. Respiration, food absorption, and excretion can be performed by osmosis and active transport across the cell membrane. Some species have organelles for the purpose of food ingestion (gullet or cytostome), and for excretion (cytopyge). Encystation may be used by these organisms in response to adverse environment and/or for reproduction. The parasitic members of this class are divided into two groups: the lumen flagellates, which inhabit the body orifices, the intestines and the bladder; and the blood and tissue flagellates. There are many members of this class which are pathogenic to man. These include lumen flagellates such as Giardia lamblia and members of the Trichomonas species and blood and tissue flagellates from the Trypanosoma and Leishmamia species.

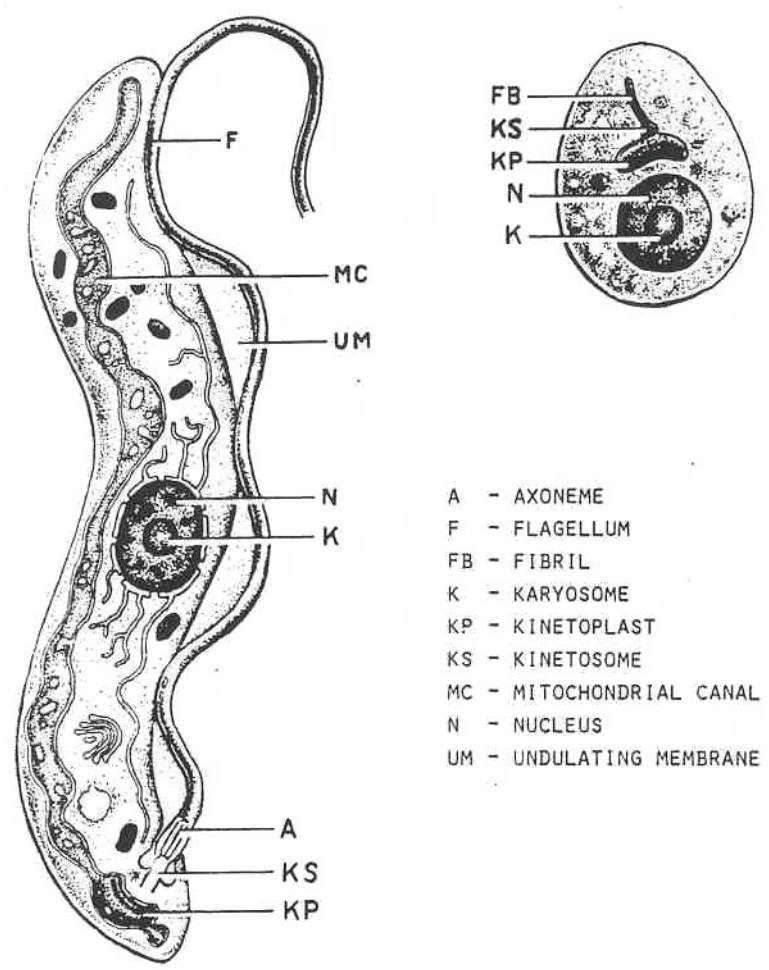



Figure 1-20. Typical flagellate.

## 1-10. LUMEN FLAGELLATES

The lumen flagellates pathogenic to men are: Giardia lamblia, Thrichomonas vaginalis, and Trichomonas hominis.

### ORGANISM 1 -- Giardia lamblia

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan; pocket of endemic behavier in Colorado.
PATHOGENESIS: Giardiasis.
SEROLOGICAL DIAGONSIS: Agglutination test, fluorescent antibody, enzyme linked-immunosorbant assay (ELISA).
HABITAT: Small intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None.
INFECTED FORM: Mature, quadrinucleated cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces, dukodenal aspirates.

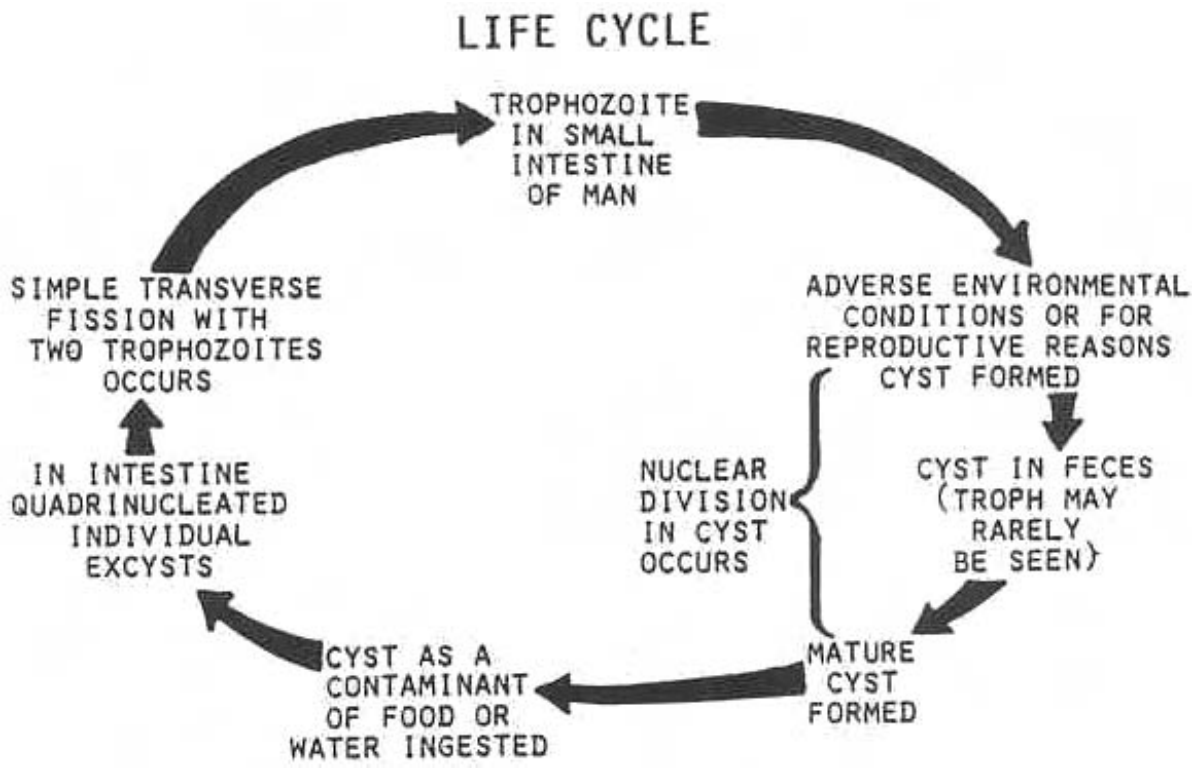

LIFE CYCLE
TROPHOZOITE IN SMALL INTESTINE OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS OR FOR REPRODUCTIVE REASONS CYST FORMED
CYST IN FECES (TROPH MAY RARELY BE SEEN)
NUCLEAR DIVISION IN CYST OCCURS
MATURE CYST FORMED
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN INTESTINE QUADRINUCLEATED INDIVIDUAL EXCYSTS
SIMPLE TRANSVERSE FISSION WITH TWO TROPHOZOITES OCCURS

Figure 1-21. Life cycle of Giardia lamblia.

## Giardia lamblia (continued)

TROPHOZOITE

SIZE: 9 to20 mcm.
SHAPE : Pear-shape; sucking disc; "Wry little face."
DORSAL SURFACE: Convex.
VENTRAL SURFACE: Concave.
NUCLEUS: Two.
CYTOPLASM:
FLAGELLA: 8.
ANTERIOR: 4.
VENTRAL: 2.
CAUDAL: 2.
KINETOSOMES: Give rise to the flagella; located between the anterior portion of the nuclei.
AXONEMES: Interior portion of the flagella; transverse the cytoplasm before emerging; the two caudal axonemes divide the body longitudinally into halves.
MEDIUM BODIES: Large curved, dark-stained.
FUNCTION: Unknown; support or energy production.
PREVIOUS IDEOLOGY: Parabasal bodies, kinetoplasts, or chromatoid bodies.
AXOSTYLES: There are none; what was believed to be axostyles are structures formed by the axonemes of the ventral flagella and the associated groups of microtubules.
MOBILITY: Like a falling leaf

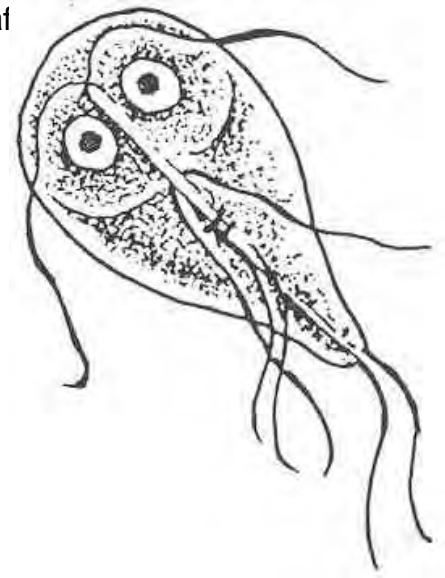


Figure 1-22. Stages of G. lamblia (continued).

CYST

SIZE: 8 to 14 mcm.
SHAPE: Ovoid to ellipsoidal.
NUCLEUS: 2 to 4.
CYTOPLASM: Remnants of flagella, kinetosomes, axonemes, and median bodies; cytoplasm is detached from the cyst wall.

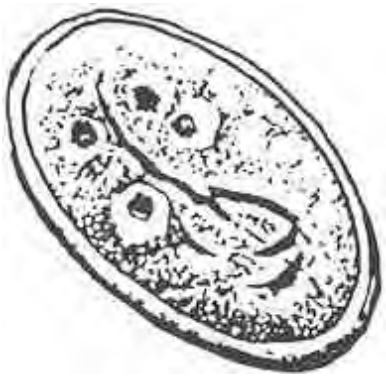


Figure 1-22. Stages of G. lamblia (concluded).

## ORGANISM 2 -- Chilomastix mesnili

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic.
HABITAT: Colon.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None.
INFECTED FORM: Mature.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

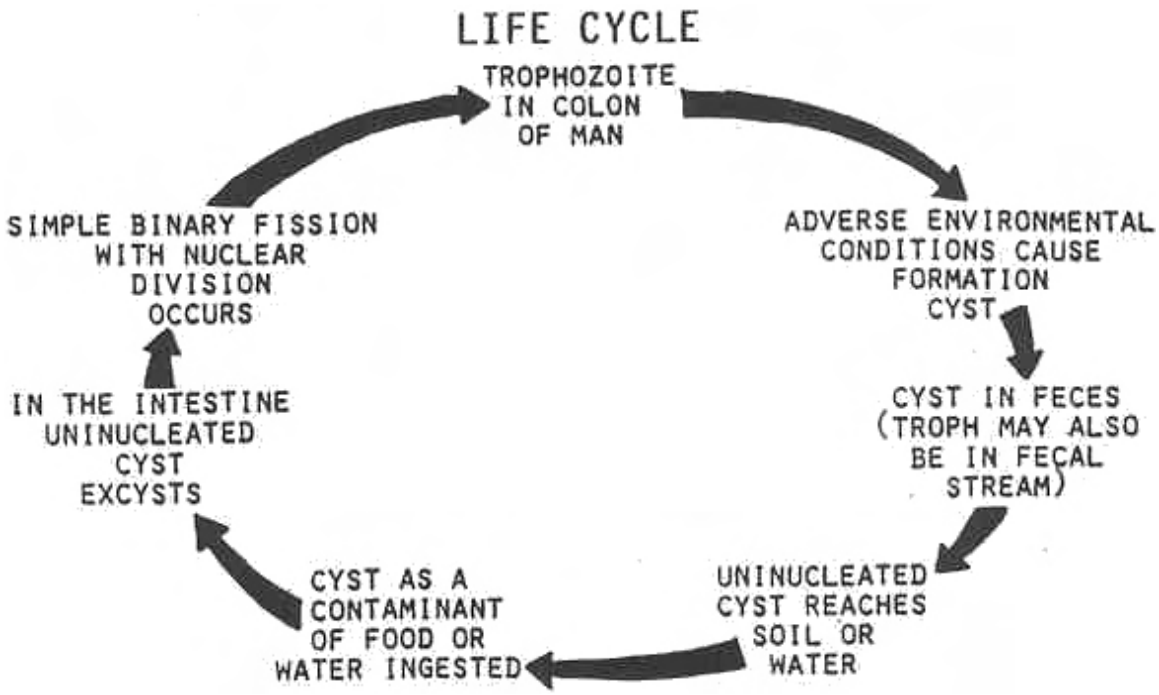

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE FORMATION CYST
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
UNINUCLEATED CYST REACHES SOIL OR WATER
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE UNINUCLEATED CYST EXCYSTS
SIMPLE BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 1-23. Life cycle of Chilomastic mesnili.

TROPHOZOITE

SIZE: 6 to24 mcm.
SHAPE : Pyriform; asymmetrical; with a longitudinal spiral torsion.
NUCLEUS: One; relatively big; large nucleus to cytoplasm ratio; usually found at the anterior portion of the organism, by the cystoplasmic membraine.
CYTOPLASM:
FLAGELLA:
EXTERNAL: three; anterior.
INTERNAL: One; cytostomal.
KINETOSOMES: Anterior; connected by microfibrils.
CYTOSTOMAL GROOVE: Prominent; near the anterior end; hour-glass shape.
CYTOSTOMAL FIBRIL: Support; along each side of the cytostomal groove.
MOBILITY: Stiff and rotary.

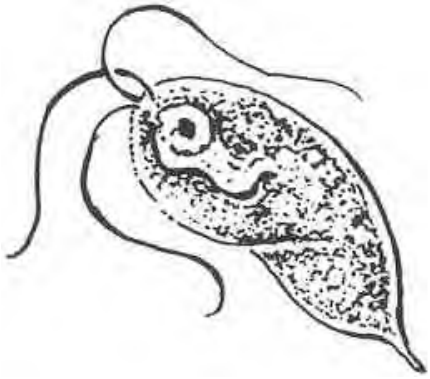


Figure 1-24. Trophozoite, C. mesnili.

CYST

SIZE: 6 to10 mcm.
SHAPE : Lemon-shape, ovoid.
NUCLEUS: One.
CYTOPLASM: Remnants of flaagella, kinetosomes, and cytostomal groove (hour-glass shape); hyaline anterior nipple.

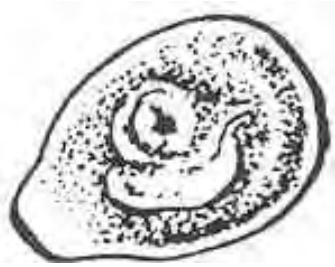


Figure 1-25. Cyst, C. mesnili.

## ORGANISM 3 -- Trichomonas species

### GENERAL CHARACTERISTICS

COMMON NAME: None.
PATHOGENESIS:
Trichomonas vaginalis:
Females: Vaginitis, pruritis; strawberry cercix.
Males: Urethritis; prostatovesiculitis.
Trichomonas hominis: Questionable pathogenicity; intestinal disorders; endemic problem in honosexual communities.
Trichomonas tenax: opportunistic pathogen.
HABITAT:
Trichomonas vaginalis: Genitourinary tract.
Trichomonas hominis: Colon.
Trichomonas tenax: Mouth.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None.
INFECTED FORM: Trophozoite.
MODE OF INFECTION:
Trichomonas vaginalis: Sexual contact.
Trichomonas hominis: Ingestion.
Trichomonas tenax: Direct contact.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE:
Trichomonas vaginalis: Vaginal and urethral discharges; prostate exudates.
Trichomonas hominis: Feces.
Trichomonas tenax: Gingival scrapings.

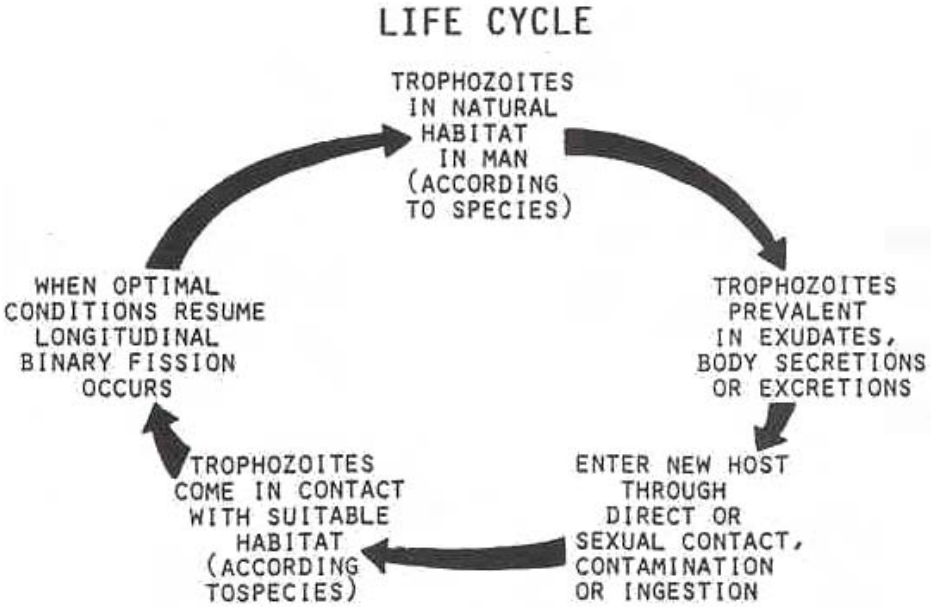

LIFE CYCLE
TROPHOZOITES IN NATURAL HABITAT IN MAN (ACCORDING TO SPECIES)
TROPHOZOITES PREVALENT IN EXUDATES, BODY SECRETIONS OR EXCRETIONS
ENTER NEW HOST THROUGH DIRECT OR SEXUAL CONTACT, CONTAMINATION OR INGESTION
TROPHOZOITES COME IN CONTACT WITH SUITABLE HABITAT (ACCORDING TOSPECIES)
WHEN OPTIMAL CONDITIONS RESUME LONGITUDINAL BINARY FISSION OCCURS

Figure 1-26. Life cycle of Trichomonas species.

TROPHOZOITE

SIZE:

Trichomonas vaginalis: 8 to 30 mcm.
Trichomonas hominis: 8 to 20 mcm.
Trichomonas tenax: 6 to 17 mcm.

SHAPE : Pyriform to oval

NUCLEUS: One (eye spot).

FLAGELLA:

Trichomonas vaginalis: 4 anterior.
Trichomonas hominis: 5 anterior and 1 posterior.
Trichomonas tenax: 4 anterior.

UNDULATING MEMBRANE:

Trichomonas vaginalis: 1/3 to 1/2 the length of the organism.
Trichomonas hominis: Full length of the body.
Trichomonas tenax: 1/2 to 2/3 the length of the body.

COSTA: Arises at the kinetostome and travels beneath and parallel to the undulating membrane.

ACCESSORY FILIMENT: Lamelar structure located just inside the undulating membrane and courses along its length.

PARABASAL BODY: Golgi apparatus; near the nucleus

AXOSTYLES: Formed by a sheet of microtubules

CYTOSTOME: Absent.

MOBILITY: Vibrates; nervous; jerky.

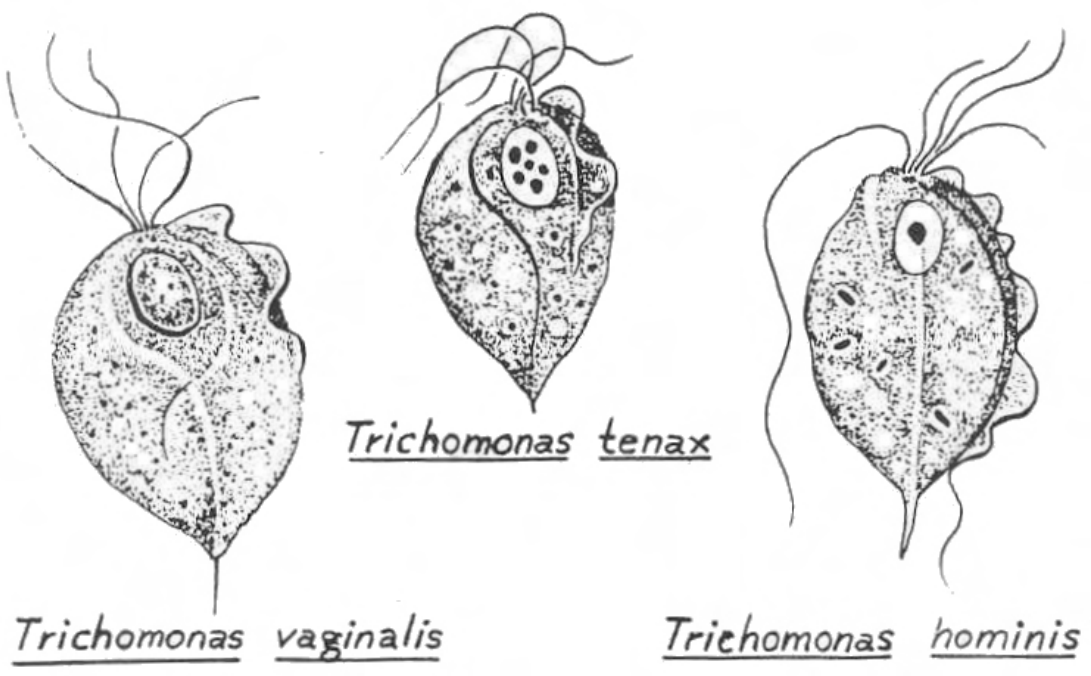



Figure 1-27. **Trichomonas** pathogens.

## ORGANISM 4 -- Dientamoeba fragilis

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Questionable pathogen, mild diarrhea.
HABITAT: Colon and cecum.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None.
INFECTED FORM: Trophozoite.
MODE OF INFECTION: Unknown; with the ova of pinworms.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

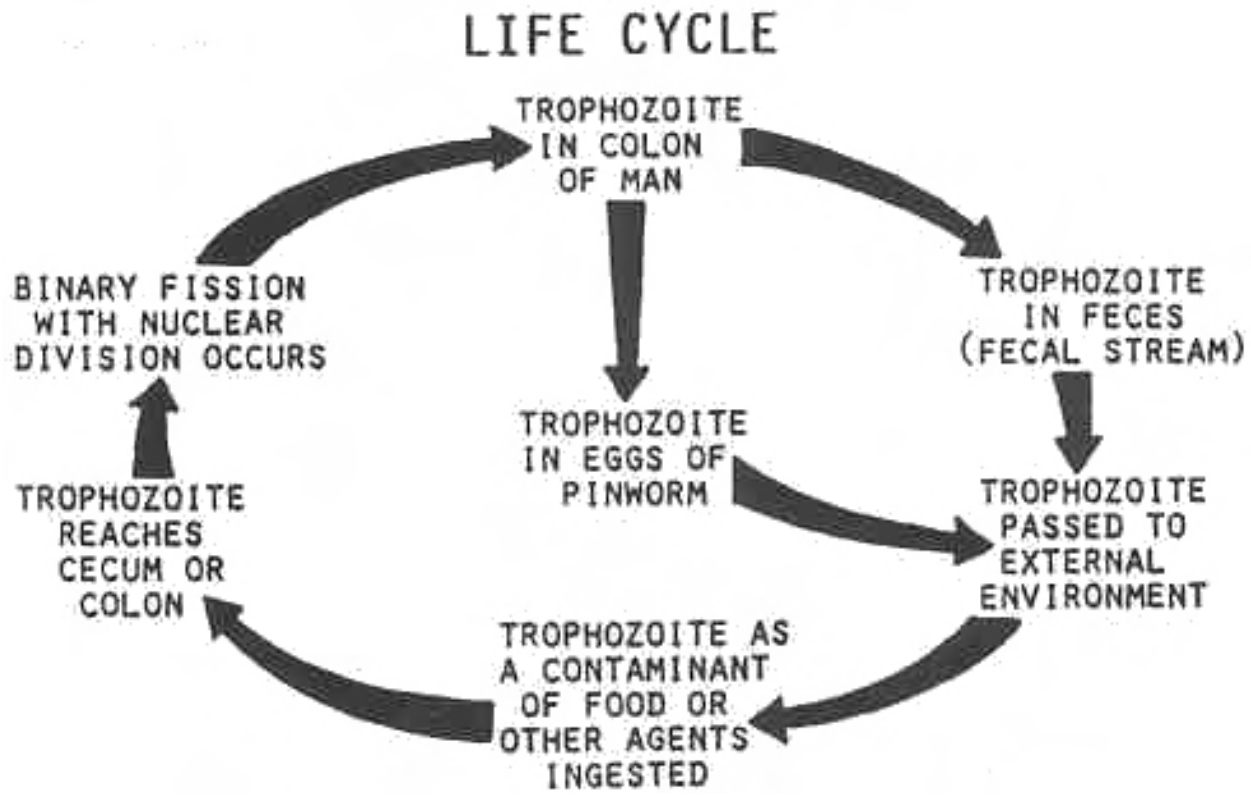

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
TROPHOZOITE IN FECES (FECAL STREAM)
TROPHOZOITE IN EGGS OF PINWORM
TROPHOZOITE PASSED TO EXTERNAL ENVIRONMENT
TROPHOZOITE AS A CONTAMINANT OF FOOD OR OTHER AGENTS INGESTED
TROPHOZOITE REACHES CECUM OR COLON
BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 1-28. Life cycle of Dientamoeba fragilis.

TROPHOZOITE

SIZE: 8 to 9 mcm.
SHAPE : Round to oval.
NUCLEUS: Vesicular; condensed.
NUMBER: Two
KARYOSOME: Broken; "lumps of coal".
PERIPHERAL CHROMATIN: Absent.
CYTOPLASM:
APPEARANCE: Granular; vacuolated.
ORGANELLES: Vacuoles; bacteria, yeast; pseudopodia; broad, often serrated, hyaline.

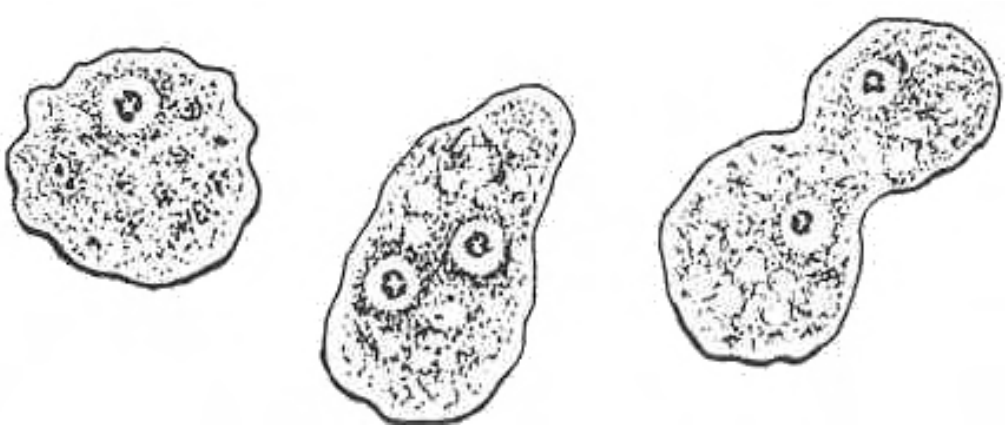


Figure 1-29. Trophkozoites, Dientamoeba fragilis

CYST

No cystic stage known.

## ORGANISM 5 -- Retortamonas intestinalis (Embadamonas)

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic.
HABITAT: Colon.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Rats, guinea, pigs, simians.
INFECTED FORM: Cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

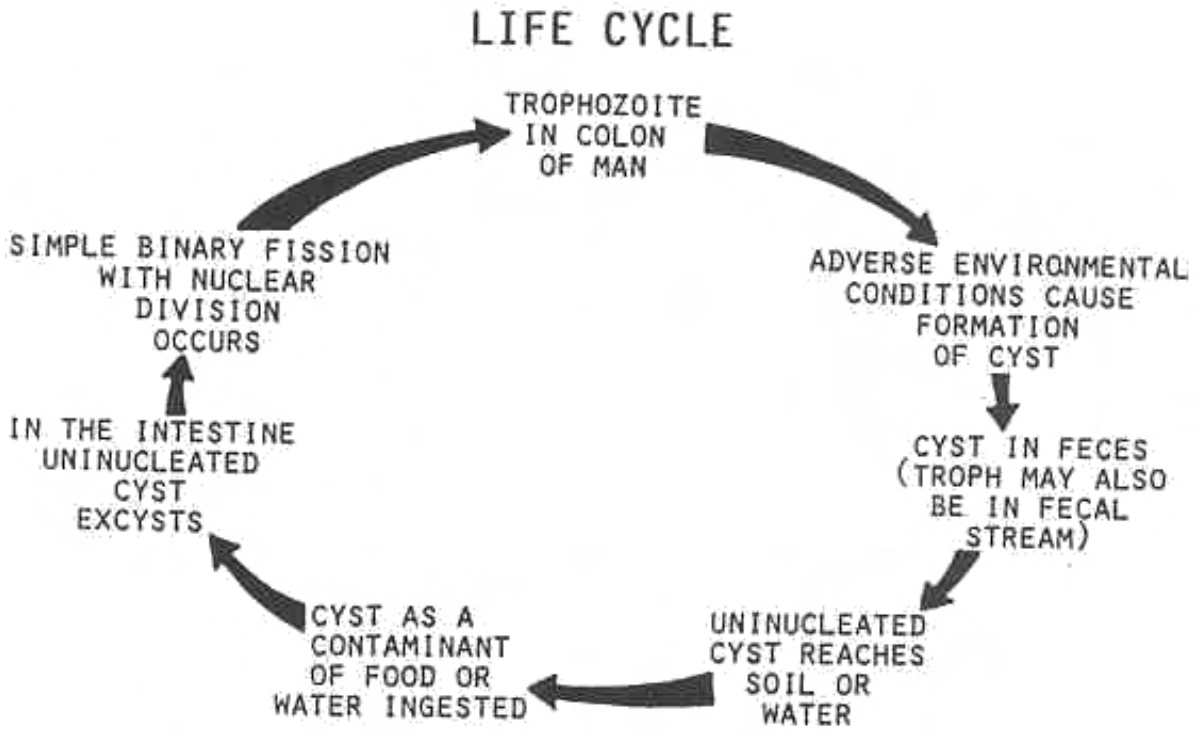

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE FORMATION OF CYST
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
UNINUCLEATED CYST REACHES SOIL OR WATER
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE UNINUCLEATED CYST EXCYSTS
SIMPLE BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 1-30. Life cycle of Retortamonas intestinalis.

## Retortamonas intestinalis (Embadamonas) (continued)

TROPHOZOITE

Similar to C. mesnili.
SIZE: 4 to 9 mcm.
SHAPE : Pyriform.
NUCLEUS: Single.
CYTOPLASM:
APPEARANCE: Granular.
ORGANELLES: Cytostomal groove.
FLAGELLA: One anterior and one cystostomal.
MOBILITY: Rapid and jerky.

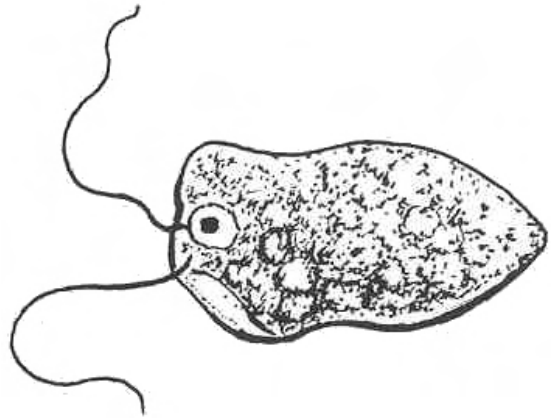


Figure 1-31. Trophozoite, Retortamonas intestinalis.

CYST

Similar to C. mesnili.
SIZE: 4 to 6 mcm.
SHAPE : Ovid.
NUCLEUS: One; indistinct
CYTOPLASM: Two fibrils; suggest "bird's beak."

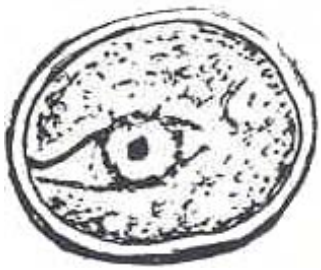


Figure 1-32. Cyst, Retortamonas intestinalis.

## ORGANISM 6 -- Enteromonas hominis (Octomitus)

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Nonpathogenic.
HABITAT: Intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Rabbits, guinea pigs, pigs.
INFECTED FORM: Cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Feces.

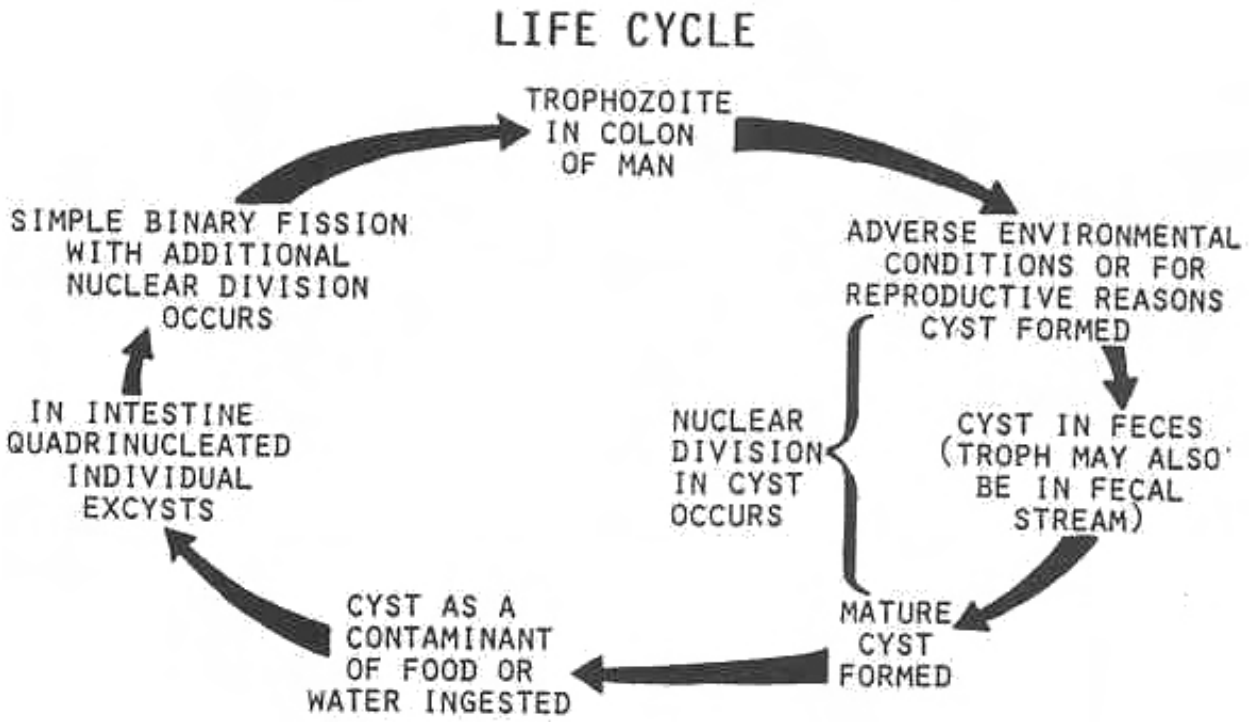
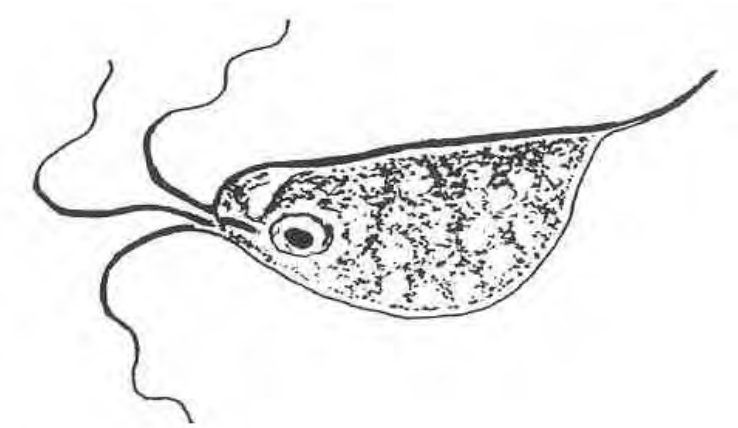

LIFE CYCLE
TROPHOZOITE IN COLON OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS OR FOR REPRODUCTIVE REASONS CYST FORMED
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
NUCLEAR DIVISION IN CYST OCCURS
MATURE CYST FORMED
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN INTESTINE QUADRINUCLEATED INDIVIDUAL EXCYSTS
SIMPLE BINARY FISSION WITH ADDITIONAL NUCLEAR DIVISION OCCURS

Figure 1-33. Life cycle of Enteromonas hominis.

## Enteromonas hominis (Octomitus) (continued)

TROPHOZOITE

SIZE: 4 to 10 mcm.
SHAPE : Pyriform.
NUCLEUS: Single, distinct nuclear membrane; large, central karyosome.
CYTOPLASM:
APPEARANCE: Granular.
ORGANELLES: Flagella (one anterior and one posterior(, no cytostomal groove.
MOBILITY: Rapid and jerky.



CYST

Simular to Endolimax nana.
SIZE: 6 to 8 mcm.
SHAPE : Oval.
NUCLEUS:
NUMBER: 1 to 4, (predominant: binucleate form).
CYTOPLASM: Finely granular.

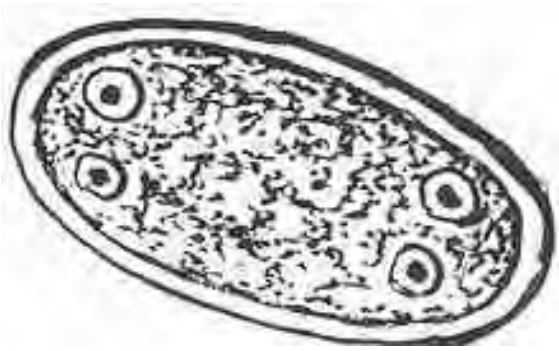


Figure 1-34. Stages of Enteromonas hominis.

## 1-11. BLOOD AND TISSUE FLAGELLATES

The pathogenic hemoflagellates belong to the family Trypanosomatidae. They are Trypanosoma species and Leishmania species.

Family Trypanosomatidae--THE HEMOFLAGELLATES

### GENERAL CHARACTERISTICS

TWO GENERA--Leishmania, Trypanosoma.

ORGANELLES OF LOCOMOTION
- KINETOPLAST: Position varies with organism and morphological forms; location correlates with structural forms.
- FLAGELLUM: Free, absent in some structural forms.
- UNDULATING MEMBRANE--Found in some structural forms.
- KINETOSOME--Indistinct

### STRUCTURAL STAGES

AMASTIGOTE

"L-0 body," Leishman-Donovan bodies, found intracellular in reticuloendothelial cells, identification form for Leishmania.

SIZE--2 to 5 mcm.
SHAPE--Oval.
NUCLEUS: Large, spherical.
KINETOPLAST: Large, rod shaped.
FLAGELLUM: Absent
PRESENCE IN THE HUMAN HOST: Yes.
AXONENE: Rarely seen as short, internal stem,
GIEMSA STAIN: Red nucleus, light blue cytoplasm.

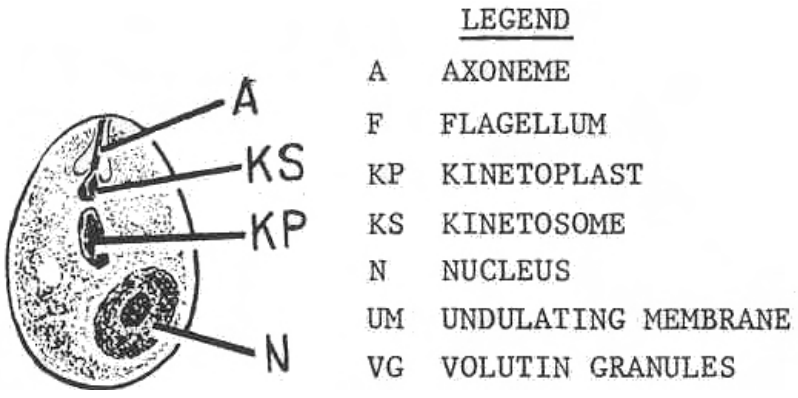
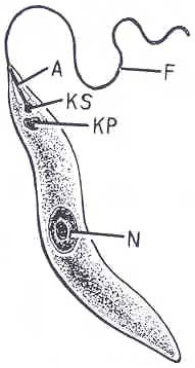



Figure 1-35. Structural stages of hemoflagellates. (continued)

PROMASTIGOTE

Found in the mid gut of the insect host. Infective form of Leishmania.
SIZE--3 to 15 mcm.
SHAPE--Elongate.
NUCLEUS: Central.
KINETOPLAST: Anterior to nucleus.
UNDULATING MEMBRANE: Absent.
FLAGELLUM: Short at anterior end.
PRESENCE IN THE HUMAN HOST: Yes.




EPIMASTIGOTE

Found in the mid gut of the insect host.
SIZE--15 to 20 mcm in length.
SHAPE--Elongate.
NUCLEUS: Generally centrally located.
KINETOPLAST: Immediately anterior to nucleus.
UNDULATING MEMBRANE: Present.
FLAGELLUM: Free, anterior.
PRESENCE IN THE HUMAN HOST: Yes.

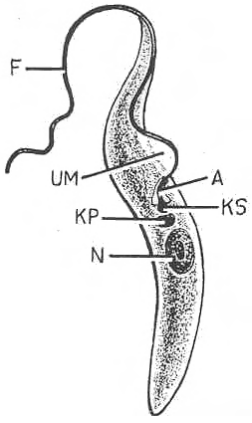
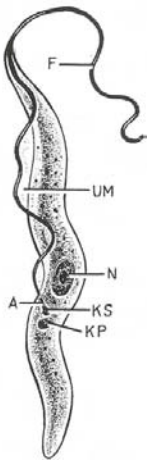



Figure 1-35. Structural stages of hemoflagellates. (continued)

METACYCLIC TRYPOMASTIOGOTE

Found in the hindgut of the insect host. Infective form of Leishmania.
SIZE--16 to 40 mcm.
SHAPE--Elongate.
NUCLEUS: Centrally located.
KINETOPLAST: Posterior to nucleus.
UNDULATING MEMBRANE: Present.
FLAGELLUM: Free, anterior.
PRESENCE IN THE HUMAN HOST: Yes.




TRYPOMASTIGOTE

Found in the circulatory system. Definitive stage of Trypanosoma in man..
SIZE--16 to 36mcm.
SHAPE--"S" shaped common with T. brucei, "C" or "U" shape common with T. cruzi.
NUCLEUS: Generally central in located.
KINETOPLAST: At posterior end.
UNDULATING MEMBRANE: Present.
FLAGELLUM: Free.
PRESENCE IN THE HUMAN HOST: Yes.

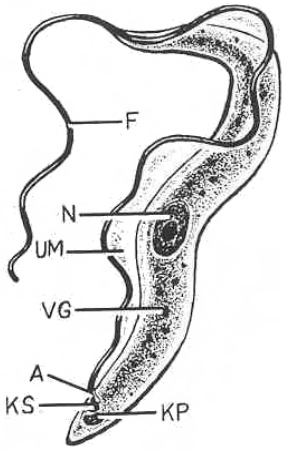



Figure 1-35. Structural stages of hemoflagellates. (concluded)

## ORGANISM 1--Leishmania species

## GENERAL CHARACTERISTICS

COMMON NAME

Leishmania donovani--Kala-azar: visceral leishmaniasis
Leishmania donovani infantum: infantile visceral leishmaniasis Leishmania donovani archibaldi--visceral leishmaniasis
Leishmania donovani chagasi: American visceral leishmaniasis
Leishmania tropica major: cutaneous leishmaniasis, Oriental sore
Leishmania tropica tropica: oriental sore, cutaneous leishmaniasis, urban Leishmania aethiopica--cutaneous leishmaniasis
Leishmania mexicana mexicana: chiclero ulcer, cutaneous leishmaniasis Leishmania peruviana--uta, cutaneous leishmaniasis
Leishmania braziliensis braziliensis: espundia, American leishmaniasis, mucocutaneous leishmaniasis

PATHOGENESIS

Viscera l leishmaniasis: destroys reticulo-endothelial cells (R-E cells); decreases production of RBC'S; hepatosplenomegaly; frequently fatal; immunity: gamma globulins, only after recovery from the first infection.

Cutaneous leishmaniasis: shallow, dry scaly sore; "wet-sore": "punched out" appearance; facial disfiguring; seldom fatal; immunity; vaccination is available;parents intentionally infect their children in an unexposed area thereby allowing acquired immunity and preventing facial disfigureme

Mucocutaneous leishmaniasis: sores with moist centers, masses of necrotic tissue; marked deformities; frequently fatal.

GEOGRAPHICAL DISTRIBUTION

L. donovani donovani: India, Burma
L. donovani infantum: Mediterranean shoreline
L. donovani archibaldi: Africa: Kenya, Gold & Ivory Coasts L. donovani chagasi--Latin America
L. tropica major: Africa, Asia, Europe
L. tropica tropica:Africa, Asia, Europe L. aethiopica--Ethiopia, Kenya
L. mexicana mexicana:Mexico to Panama T. peruviana--Peruvian Andes (3000 m.)
L. braziliensis braziliensis: Central & Northern South America

HABITAT: Phagocytic R-E cells and macrophages.
INTERMEDIATE HOST: Sandfly, Phlebotomus species.
RESERVOIR HOST: Cats, dogs, horses, sheep, and others.

**Leishmania species (Continued)**

INFECTED FORM: Promastigote.
MODE OF INFECTION: Bite of the vector (injection)..
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Tissue biopsy, bone marrow, skin.

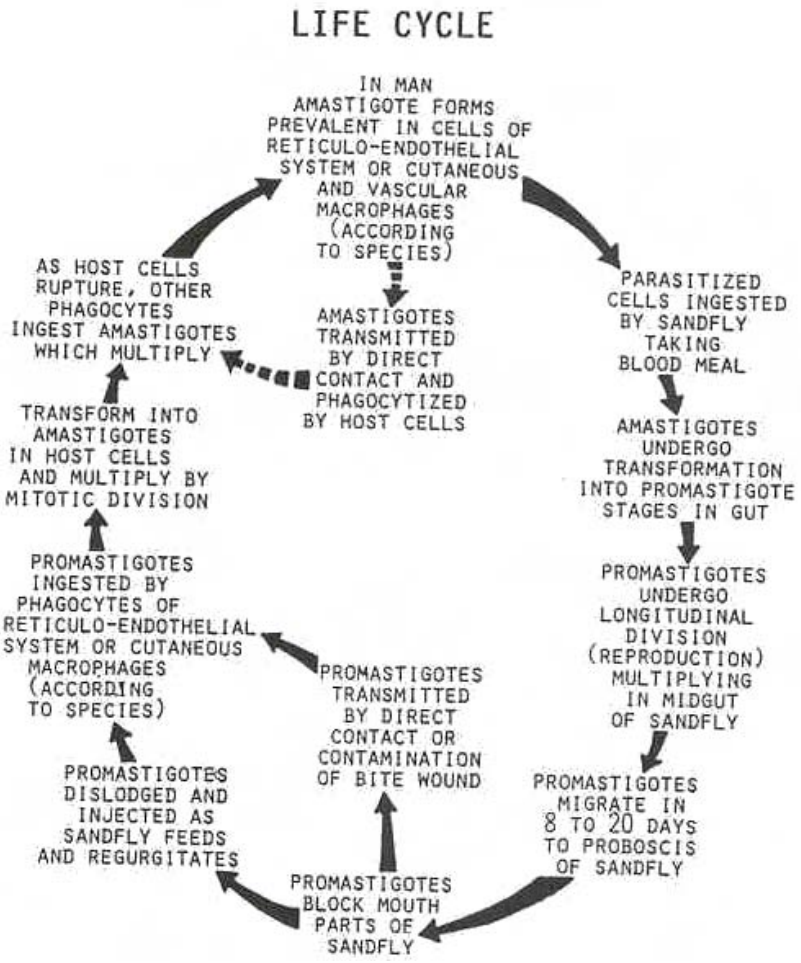
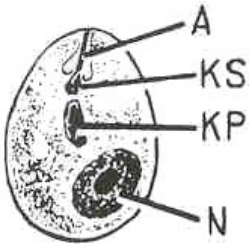



Figure 1-36. Life cycle of Leishmania species.

AMASTIGOTE

Intracellular (Donovan bodies in Giemsa or Wright stain.



## ORGANISM 2--Trypanosoma brucei

## GENERAL CHARACTERISTICS

COMMON NAME
T. brucei gambiense: West African sleeping sickness.
T. brucei rhodesiense: East African sleeping sickness.

PATHOGENESIS
T. brucei gambiense: chronic, lasts for years.
T. brucei rhodesiense: easily cured at circulatory stage; fatal in three to nine months.

GEOGRAPHICAL DISTRIBUTION
T. brucei gambiense: western and central Africa.
T. brucei rhodesiense: eastern and central Africa; very seldom overlap; one may replace the other in an area.

HABITAT: Central nervous system, lymph nodes, spleen, and other internal organs.
INTERMEDIATE HOST: Tse-Tse fly, Glossina species.
RESERVOIR HOST: T. brucei gambiense: domestic animals
T. brucei rhkodesinse: Game animals.
INFECTIVE FORM: Metacyclic trypomastigote
MODE OF INFECTION: Bite of Tse-Tse fly.

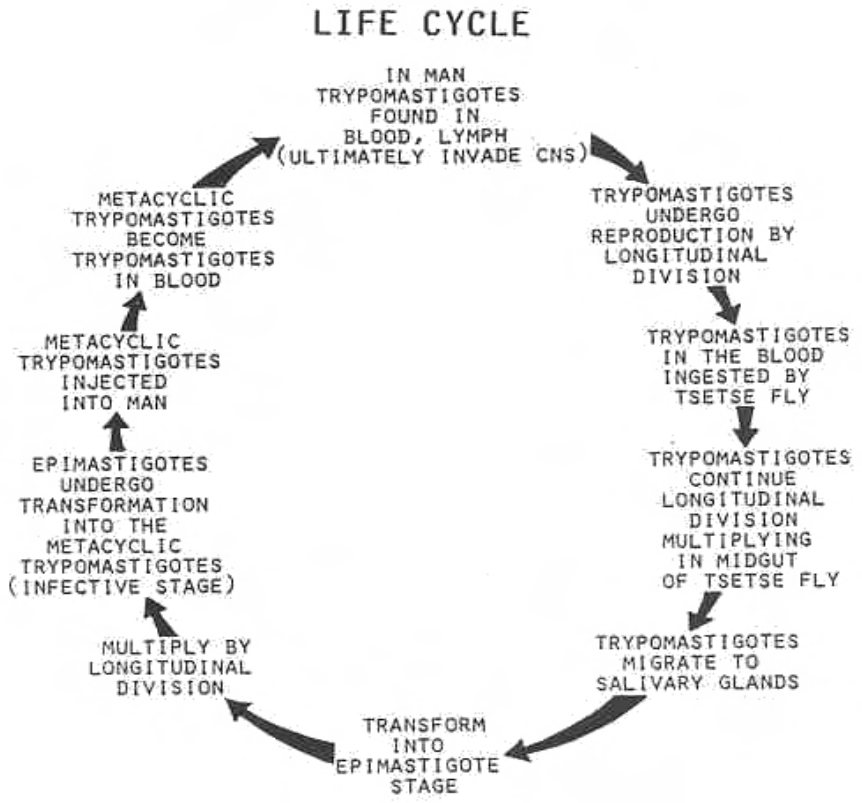

LIFE CYCLE
IN MAN TRYPOMASTIGOTES FOUND IN BLOOD, LYMPH (ULTIMATELY INVADE CNS)
TRYPOMASTIGOTES UNDERGO REPRODUCTION BY LONGITUDINAL DIVISION
TRYPOMASTIGOTES IN THE BLOOD INGESTED BY TSETSE FLY
TRYPOMASTIGOTES CONTINUE LONGITUDINAL DIVISION MULTIPLYING IN MIDGUT OF TSETSE FLY
TRYPOMASTIGOTES MIGRATE TO SALIVARY GLANDS
TRANSFORM INTO EPIMASTIGOTE STAGE
MULTIPLY BY LONGITUDINAL DIVISION
EPIMASTIGOTES UNDERGO TRANSFORMATION INTO THE METACYCLIC TRYPOMASTIGOTES (INFECTIVE STAGE)
METACYCLIC TRYPOMASTIGOTES INJECTED INTO MAN
METACYCLIC TRYPOMASTIGOTES BECOME TRYPOMASTIGOTES IN BLOOD

Figure 1-37. Life Cycle of Trypanosoma brucei. (continued)

**Trypanosoma brucei (continued)**

TRYPOMASTIGOTE

SHAPE: "S" form.
KINETOPLAST: Small.
VOLUTIN GRANULES: Present.
DIVIDING FORMS: Prevalent.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Blood, lymph, spinal fluid.

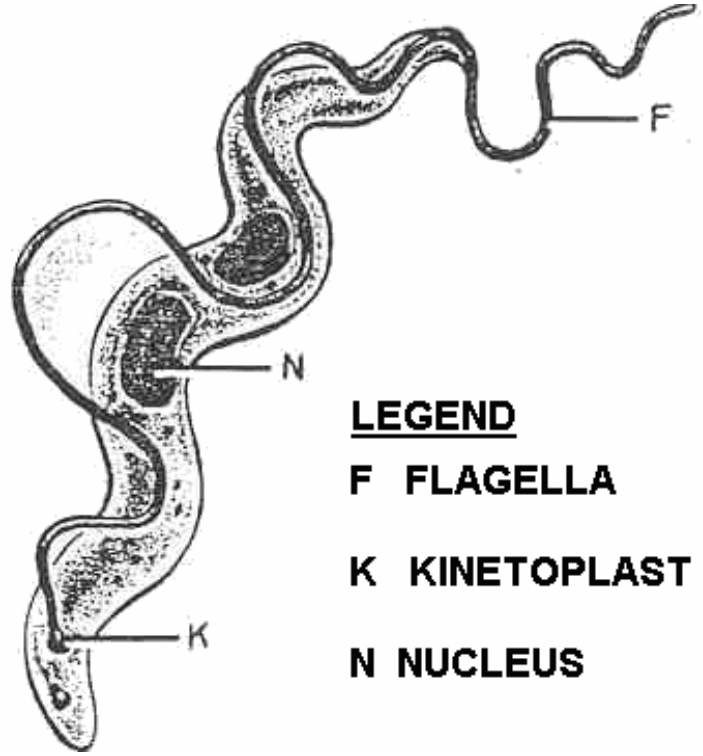



Figure 1-37. Life Cycle of Trypanosoma brucei. (concluded)

## ORGANISM 3 -- Trypanosoma cruzi

### GENERAL CHARACTERISTICS

COMMON NAME: Chaga's disease or American Trypanosomiasis.
GEOGRAPHICAL DISTRIBUTION: Western hemisphere (Central and South America.
PATHOGENESIS: Frequently fatal; localized, severe inflammation (chagoma; "Romana's sign"); cardiomyopathy; mega-disease..
XENODIAGOSIS: Infective forms in reduviid bugs; check weekly for one month.
HABITAT: Circulatory, central nervous, and reticuloendothelial systems; heart muscle; bone marrow.
INTERMEDIATE HOST: Reduviid bug; Triatoma and Panstrongylus species.
RESERVOIR HOST: Various mammals.
INFECTED FORM: Metacyclic trypomastigote.
MODE OF INFECTION: Fecal contamination of the bite.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Blood

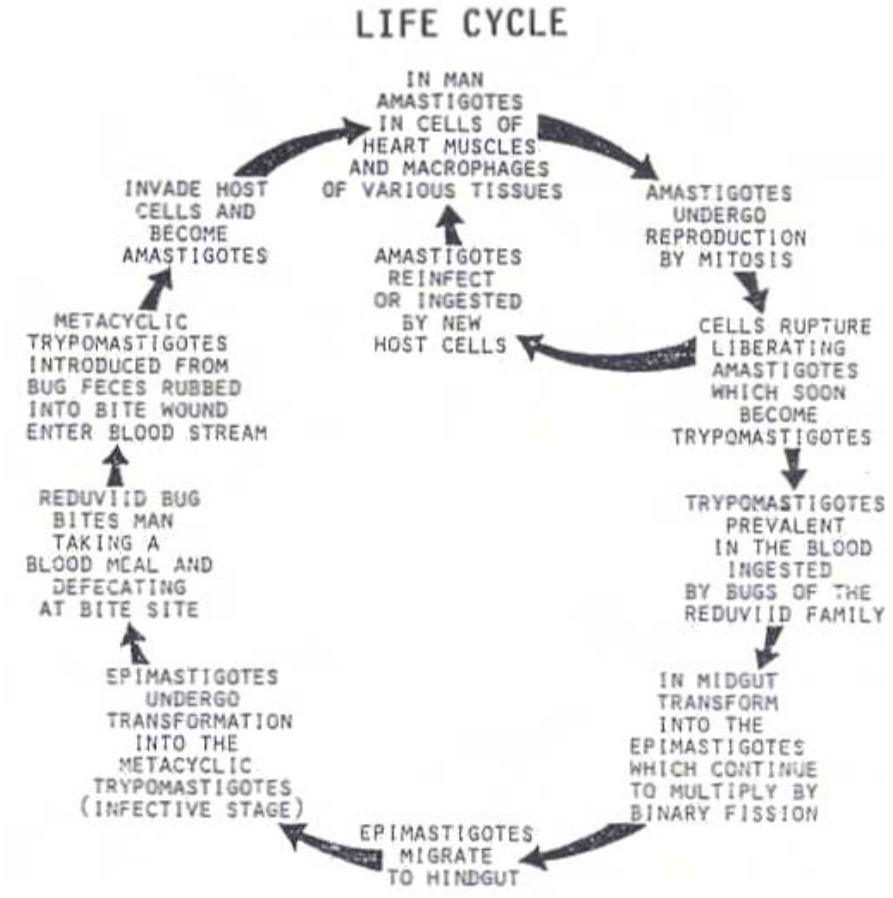



Figure 1-38. Life cycle of Trypanosoma cruzi. (continued)

TRYPOMASTIGOTE

SHAPE: "C" and "U" form.
KINETOPLAST: Large.
VOLUTIN GRANULES: Absent (usually)..
DIVIDING FORMS: Rare.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Blood

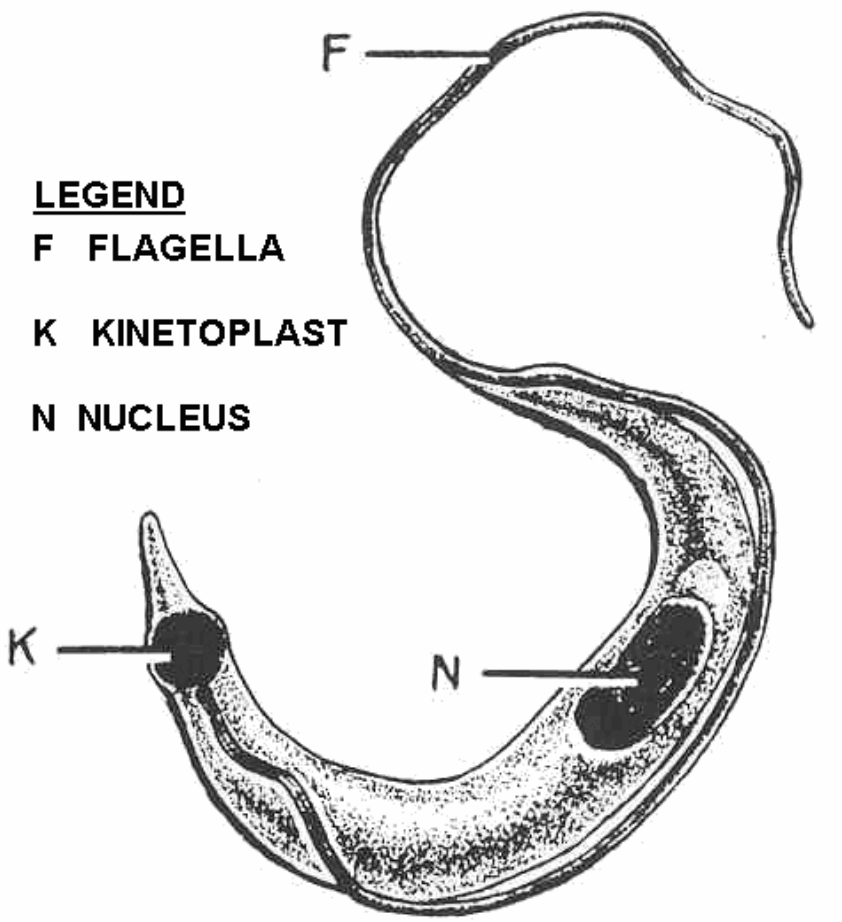



Figure 1-38. Life cycle of Trypanosoma cruzi. (concluded)

**Continue with Exercises**

**EXERCISES, LESSON 1**

**INSTRUCTIONS:** Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. All of the structural stages seen in the genera Leishmania and Trypanosoma may be found in a human host.

   a. True.

   b. False.

2. Chaga's disease is transmitted by:

   a. The bite of a Tse-Tse fly.

   b. The bite of a reduviid bug.

   c. The feces of a reduviid bug.

   d. Ingestion of infected game animals.

3. Which of the following statements best describes a phase in the life cycle of Leishmania species?

   a. The infective form is injected by the bite of a sandfly.

   b. Phagocytic RE cells ingest the infective form.

   c. The promastigote stage occurs in the gut of the intermediate host.

   d. All of the above.

4. The most easily recognized structure in a protozoan cell is:

    a. Cytoplasmic reticulum.

    b. Ectoplasm.

    c. Nucleus.

    d. Golgi complex.

5. Montezuma's revenge is caused by:

    a. Entamoeba coli.

    b. Entamoeba histolytica.

    c. Endolimax nana.

    d. Entamoeba polecki.

6. The infective form of Naegleria fowleri is:

    a. The ciliated trophozoite.

    b. The quadri-nucleated cyst.

    c. The promastigote.

    d. The biflagellated trophozoite.

7. Members of the class Zoomastigophora move by means of:

    a. Flagella.

    b. Pseudopodia.

    c. Gliding.

    d. Cilia.

8. If a trophozoite with 8 flagella is recovered from a fecal specimen, it is likely to be:

   a. Chilomastic mesnili.

   b. Trichomonas hominis.

   c. Giardia lamblia.

   d. Enteromonas hominis.

9. The infective form of Trichomonas vaginalis is the:

   a. Mature cyst.

   b. Trophozoite.

   c. Quadrinucleated cyst.

   d. Uninucleate cyst.

10. The organism which can only be differentiated from Entamoeba histolytica in the cystic stage by its size is:

    a. Entamoeba hartmanii.

    b. Entamoeba coli.

    c. Entamoeba Dolecki.

    d. Endolimax nana.

11. Locomotion among members of the class Rhizopoda is accomplished by organelles called:

    a. Flagella.

    b. Cilia.

    c. Pseudopodia.

    d. None of the above.

12. Cytoplasm in the trophozoite stage of Entamoeba coli is often described as:

    a. Finely granular with no inclusions.

    b. "Dirty" and vacuolated with yeast, bacteria and molds.

    c. Coarsely granular with RBC inclusions.

    d. "Clean" with yeast, bacteria, and molds.

13. A large, well defined glycogen vacuole is characteristic of which of the following organisms?

    a. Entamoeba histolytica.

    b. Endolimax nana.

    c. Entamoeba coli.

    d. Iodamoeba butschlii.

14. The term lemon-shape best describes the cysts of:

    a. Chilomastix mesnili.

    b. Dietamoeba fragilis.

    c. Giardia lamblia.

    d. Enteromonas hominis.

15. A possible mode of infection for Dientamoeba fragilis would be:

    a. Injection by an arthropod vector.

    b. Ingestion with the ova of pinworm.

    c. Through nasal passages while diving into water.

    d. Through sexual intercourse.

16. The appearance of two fibrils joined in the shape of a "bird's beak" is characteristic of the cysts of which organism?

    a. Enteromonas hominis.

    b. Endolimax nana.

    c. Retortamonas intestinalis.

    d. Leishmania species.

17. A diagnostic method used to recover the infective forms of Trypanosoma cruzi is:

    a. Fecal concentration.

    b. Collection of urethral or vaginal discharge.

    c. Xenodiagnosis.

    d. Collection of duodenal aspirates.

18. Which of the following sites serves as a habitat for stages of the African Trypanosomes?

    a. Lymph nodes.

    b. Spleen and other internal organisms.

    c. Central nervous system.

    d. All of the above.

**Check Your Answers on Next Page**

**SOLUTIONS TO EXERCISES, LESSON I**

1. a (para 1-11)
2. c (para 1-11, org 3)
3. d (para 1-11, org 1)
4. c (para 1-3)
5. b (para 1-8, org 1)
6. d (para 1-8, org 5)
7. a. (para 1-9)
8. c (para 1-10; org 1)
9. b (para 1-10, org 3)
10. a (para 1-8, org 2)
11. c (para 1-6)
12. b (para 1-8, org 3)
13. d (para 1-8, org 7)
14. a (para 1-10, org 2)
15. b (para 1-10, org 4)
16. c (para 1-10, org 5)
17. c (para 1-11, org 3)
18. d (para 1-11, org 2)

**End of Lesson 1**

## LESSON ASSIGNMENT

| | |
|---|---|
| **LESSON 2** | Phylum Protozoo; Ciliata, Piroplasmasida, and Sporozoa. |
| **LESSON ASSIGNMENT** | Paragraphs 2-1 through 2-11. |
| **LESSON OBJECTIVES** | After completing this lesson, you should be able to: |

2-1. Identify the organism characteristics of parasitic members of Class Ciliata.

2-2. Select a statement that best describes the life cycle of a member of Class Ciliata.

2-3. Identify the organism characteristics of parasitic members of Class Piroplasmasida.

2-4. Select a statement that best describes the life cycle of a member of Class Piroplasmasida.

2-5. Identify the organism characteristics of members of Class Sporozoa.

2-6. Select a statement that best describes the life cycle of a member of Class Sporozoa.

2-7. Identify the specimen of choice for recovery of specific protozooan organisms.

2-8. Identify the special techniques required for recovery of specific protozooan organisms.

**SUGGESTION** After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

## LESSON 2

## PHYLUM PROTOZOO: CILIATA, PIROPLASMASIOA AND SPOROZOA

## Section I. CLASS CILIATA

### 2-1. GENERAL DESCRIPTION

These organisms use small, hair-like structures called cilia (singular: cilium) for locomotion. The outer envelope of the organism is a tough but flexible area called the pellicle. Food absorption is carried out by gathering food particles with the cilia and forcing them down the gullet (cytostome), where a vacuole is produced which surrounds the food. Digestion is accomplished by internal enzymes. Excretion of the unused food is accomplished by expulsion through the anal pore (cytopyge).

### 2-2. RESPIRATION AND REPRODUCTION

Hydrostasis with the environment is controlled by a pair of contractile vacuoles. Respiration is performed by diffusion through the cell membrane. Reproduction may be attained by simple cell division or by a complex exchange of genetic material between two individuals. There is only one member of this class which is pathogenic to man: Balantidium coli.

C - CILIA
CP - CYTOPYGE
CS - CYTOSTOME
CV - CONTRACTILE VACUOLE
MA - MACRONUCLEUS
MI - MICRONUCLEUS

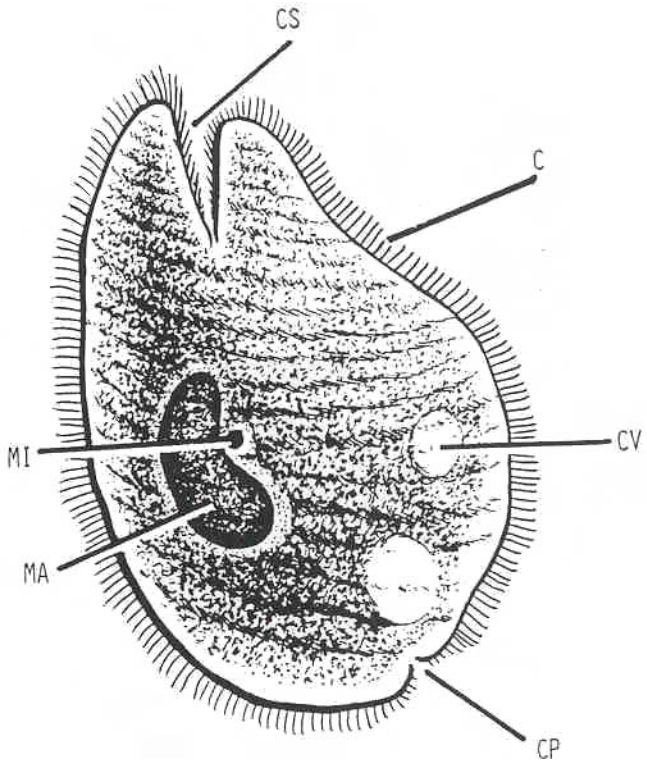



Figure 2-1. Typical ciliate.

## 2-3. PARASITIC MEMBER OF CLASS CILIATA

### ORGANISM 1--Balantidium Coli

### GENERAL CHARACTERISTICS

Only ciliate parasitic to man.
COMMON NAME: Balantidiasis, balantidial dysentery.
PATHOGENESIS: Invasion of intestinal mucosa and submucosa.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
HABITAT: Cecum.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Hogs.
INFECTIVE FORM: Mature cyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN OF CHOICE: Feces.

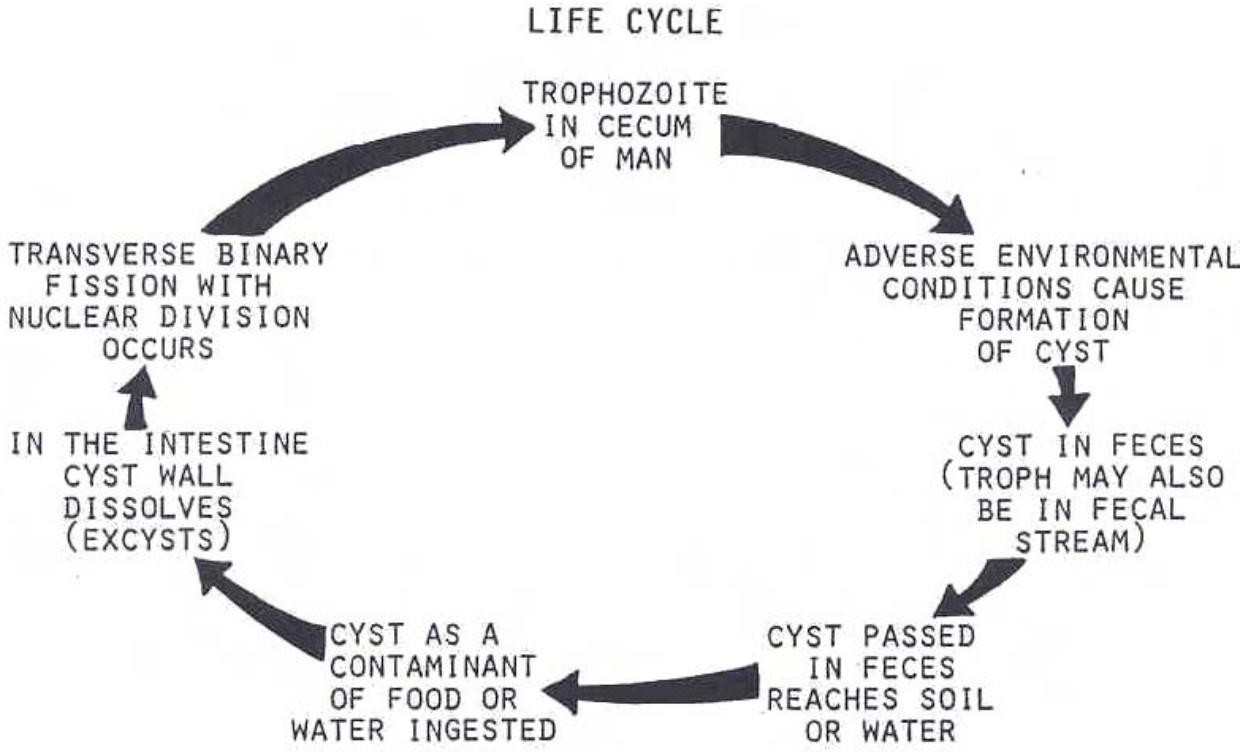
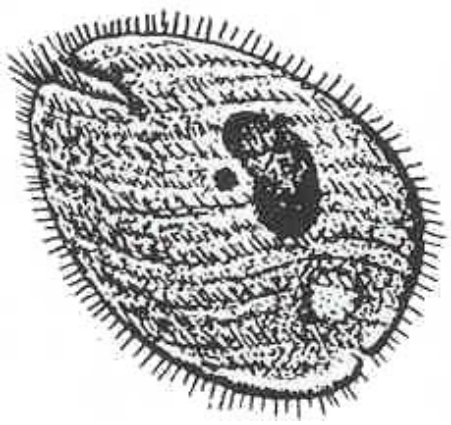

LIFE CYCLE
TROPHOZOITE IN CECUM OF MAN
ADVERSE ENVIRONMENTAL CONDITIONS CAUSE FORMATION OF CYST
CYST IN FECES (TROPH MAY ALSO BE IN FECAL STREAM)
CYST PASSED IN FECES REACHES SOIL OR WATER
CYST AS A CONTAMINANT OF FOOD OR WATER INGESTED
IN THE INTESTINE CYST WALL DISSOLVES (EXCYSTS)
TRANSVERSE BINARY FISSION WITH NUCLEAR DIVISION OCCURS

Figure 2-2. Life cycle of Balantidium coli.

TROPHOZOITE

SIZE: 40 to 50 by 50 to 70 mcm.
SHAPE: Sac-like.
NUCLEUS: Macronucleus: large, enlongate, kidney-shape (mitotic division); micronucleus: small, spherical (amitotic).
CYTOPLASM: Cell membrane covered with a delicate pellicle.
CILIA: Locomotion and food procurement; fine hair-like projections.
GULLET: Cytostome; anterior end: funnel shape peristome; posterior end: rounded, peristome.
CYTOPYGE: Excretory pore, posterior.
PULSATING VACUOLES: One or two.



CYST

SIZE: 30 by 55 mcm.
SHAPE: Oval to round.
NUCLEUS: Only the macronucleus is seen.
CYTOPLASM: Double cyst wall; remnants of cilia and gullet.

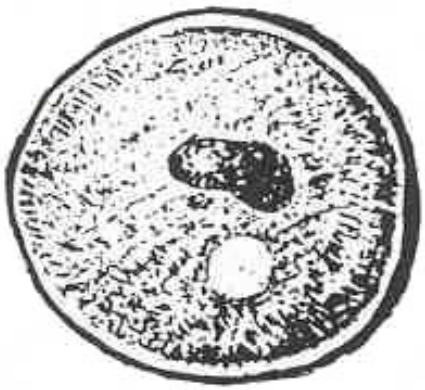


Figure 2-3. Stages of B. coli.

## Section II. CLASS PIROPLASMASIDA

### 2-4. CLASS

Members of Class Piroplasmasida, genus Babesia are characterized by bodies which are small, pyriform to ameboid. They possess no spores, flagella, or cilia.

### 2-5. FUNCTION

The reproduction is asexual by cell division or schizogony. In the life cycle, ticks are used as vectors. In some publications, these organisms are placed in the Class Sporozoa.

### 2-6. PARASITIC MEMBER OF CLASS PIROPLASMASIDA

**ORGANISM 1--CLASS Piroplasmasida--Genus Babesia**

**GENERAL CHARACTERISTICS**

COMMON NAME: Redwater fever; piroplasmosis; babesiosis.
PATHOGENESIS: Many species are pathogenic to vertebrates; over one hundred cases in humans (splenectomized persons are most susceptible); could be fatal.
GEOGRAPHICAL DISTRIBUTION: Most cases from Nantucket Island, Massachusetts.
HABITAT: Intracellar in RBCs.
INTERMEDIATE HOST: vertebrates; man.
RESERVOIR HOST:
TICKS: Definitive host, vector.
VERTEBRATES: Intermediate host.
INFECTIVE FORM TO MAN: Vermicle.
MODE OF INFECTION: Injection.
LABORATORY IDENTIFICATION:
SPECIMEN OF CHOICE: Blood.

## **Babesia** (Continued)

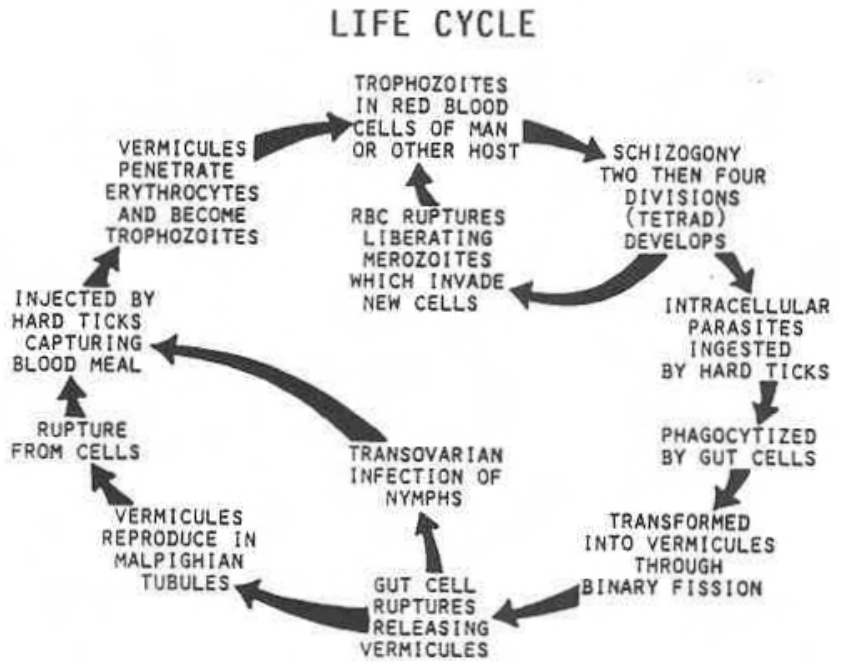

LIFE CYCLE
TROPHOZOITES IN RED BLOOD CELLS OF MAN OR OTHER HOST
SCHIZOGONY TWO THEN FOUR DIVISIONS (TETRAD) DEVELOPS
INTRACELLULAR PARASITES INGESTED BY HARD TICKS
PHAGOCYTIZED BY GUT CELLS
TRANSFORMED INTO VERMICULES THROUGH BINARY FISSION
GUT CELL RUPTURES RELEASING VERMICULES
VERMICULES REPRODUCE IN MALPIGHIAN TUBULES
RUPTURE FROM CELLS
INJECTED BY HARD TICKS CAPTURING BLOOD MEAL
VERMICULES PENETRATE ERYTHROCYTES AND BECOME TROPHOZOITES
RBC RUPTURES LIBERATING MEROZOITES WHICH INVADE NEW CELLS
TRANSOVARIAN INFECTION OF NYMPHS

Figure 2-4. Life cycle of Babesia.

TROPHOZOITE

SIZE: 4 by 1.5 mcm.
SHAPE: Tear-drop; ameboid; ovoid; spherical.

Present within a vacuole in the RBC.

May be confused with P. falciparum.

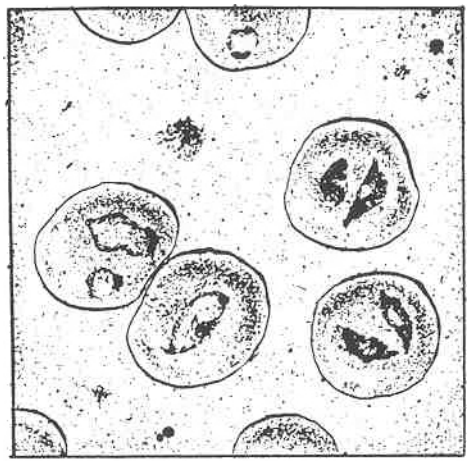


Figure 2-5. Stage of Babesia.

## Section III. CLASS SPOROZOA

### 2-7. GENERAL COMMENTS

Reproduction in this class is accomplished through both sexual and asexual cycles. All members are parasitic and usually require two hosts to complete the cycle. Sporozoans use body flexion, gliding, or undulation of longitudinal ridges as means of motility. Small pseudopods are used for feeding. There are three families in the class: family Eimeriidae, family Endodyococcidoridae, and family Plasmodiidae.

### 2-8. FAMILY EIMERIIDAE

The life cycle of the family Eimeriidae can be completed in one host, but two hosts may be used. The macrogametocytes and the microgametocytes are developed independently. The zygote is non-motile and sporozoites are formed inside a sporocyst. The members of this family parasitic to man are: Isospora belli, Eimeria species, and Cryptosporidium species.

### 2-9. FAMILY ENDODYCOCCIDORIDAE

All members are intracellular parasites of vertebrates. Three species are pathogenic to humans: Toxoplasma gondii, Sarcocystis hominis, and Pneumocystis carinii.

### 2-10. FAMILY PLASMODIIDAE

Plasmodium is the representative genus of this class. These organisms live as intracellular parasites in the red blood cells of the intermediate host (man) and multiply asexually through a process known as schizogony. In the definitive host, there is sexual reproduction which takes place in the gut, hemolymph, and salivary glands of the mosquito. The gametes are developed independently and the zygote (ookinete) is motile.

## 2-11. ORGANISMS OF CLASS SPOROZOA

### ORGANISM 1--Isospora belli

### GENERAL CHARACTERISTICS

COMMON NAME: Coccidiosis.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Few reported cases, rare local epidemics.
HABITAT: Ileocecal and jejunal region of intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None known.
INFECTIVE FORM: Oocyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN OF CHOICE: Feces.

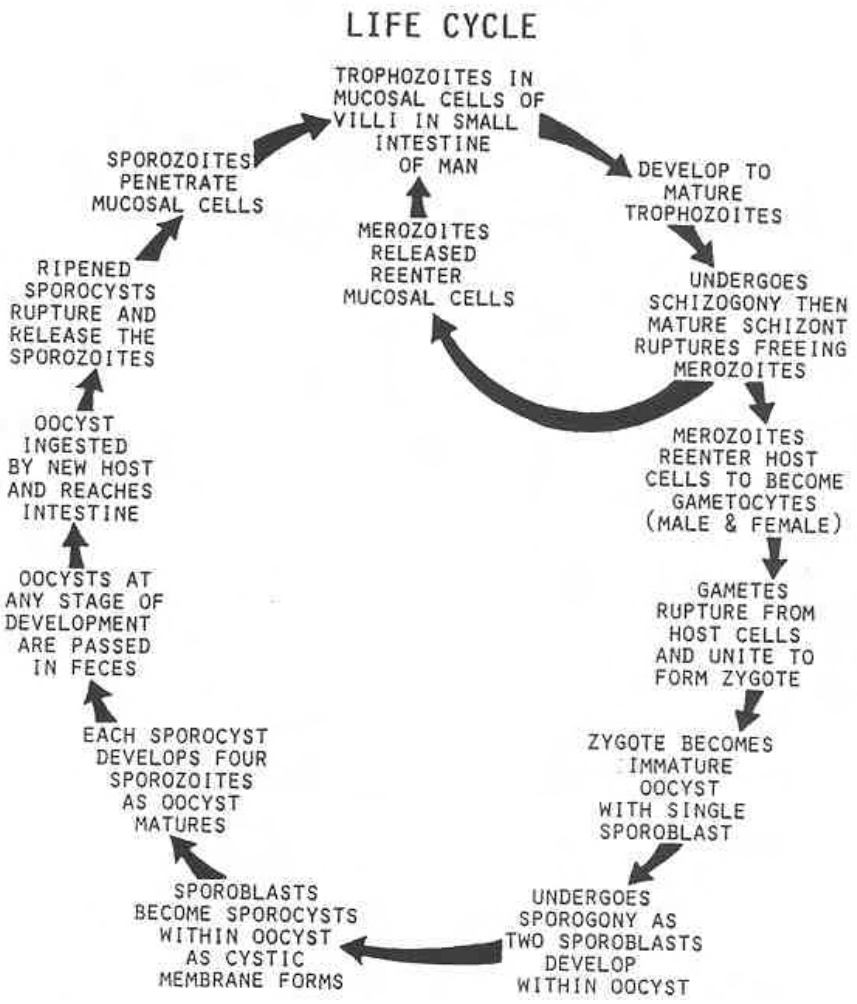
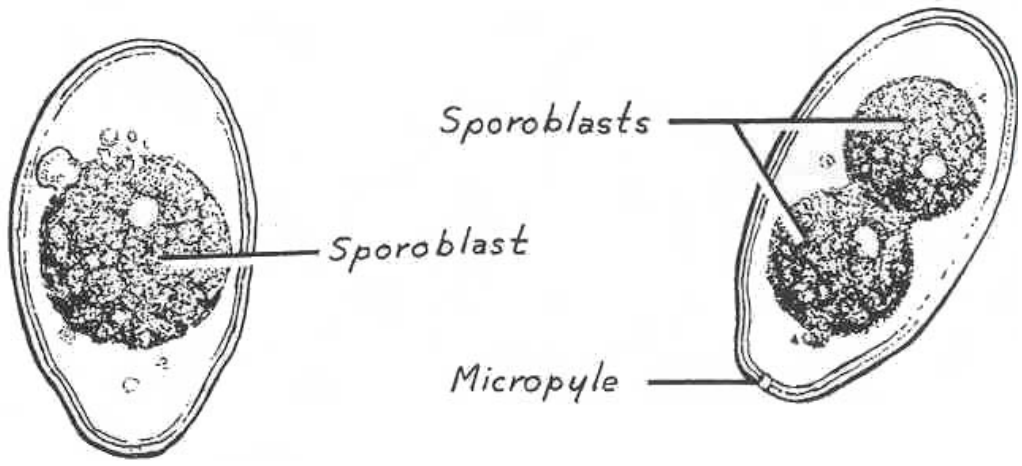

LIFE CYCLE
TROPHOZOITES IN MUCOSAL CELLS OF VILLI IN SMALL INTESTINE OF MAN
DEVELOP TO MATURE TROPHOZOITES
UNDERGOES SCHIZOGONY THEN MATURE SCHIZONT RUPTURES FREEING MEROZOITES
MEROZOITES REENTER HOST CELLS TO BECOME GAMETOCYTES (MALE & FEMALE)
GAMETES RUPTURE FROM HOST CELLS AND UNITE TO FORM ZYGOTE
ZYGOTE BECOMES IMMATURE OOCYST WITH SINGLE SPOROBLAST
UNDERGOES SPOROGONY AS TWO SPOROBLASTS DEVELOP WITHIN OOCYST
SPOROBLASTS BECOME SPOROCYSTS WITHIN OOCYST AS CYSTIC MEMBRANE FORMS
EACH SPOROCYST DEVELOPS FOUR SPOROZOITES AS OOCYST MATURES
OOCYSTS AT ANY STAGE OF DEVELOPMENT ARE PASSED IN FECES
OOCYST INGESTED BY NEW HOST AND REACHES INTESTINE
RIPENED SPOROCYSTS RUPTURE AND RELEASE THE SPOROZOITES
SPOROZOITES PENETRATE MUCOSAL CELLS
MEROZOITES RELEASED REENTER MUCOSAL CELLS

Figure 2-6. Life cycle of Isospora belli.

## **Isospora belli (Continued)**

IMMATURE OOCYST

THIN CYST WALL
OVOID
12 x 30 mcm
ONE OR TWO SPOROBLASTS




MATURE OOCYST

TWO SPOROCYSTS: 8 x 12 mcm
EACH SPOROCYST CONTAINS FOUR SPOROZOITES

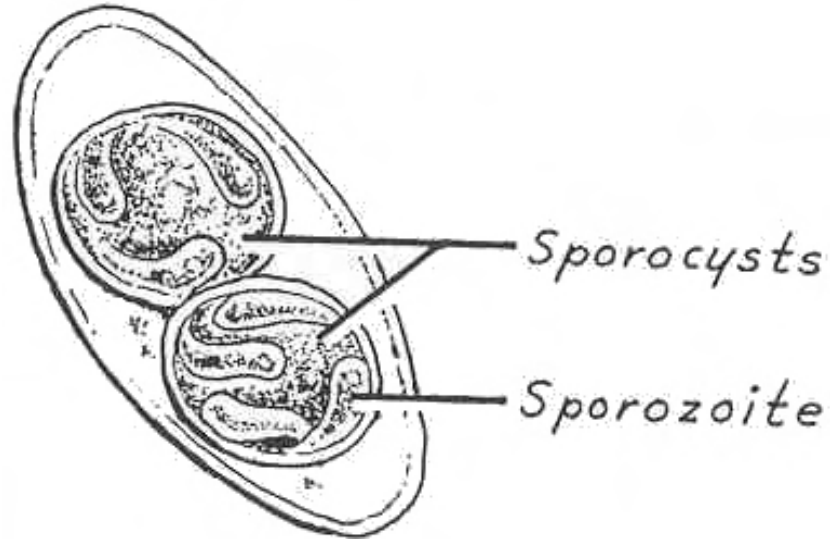



Figure 2-7. Stages of I. belli.

## ORGANISM 2--Eimeria species

PARASITES OF BIRDS, REPTILES, AND MAMMALS OTHER THAN MAN

OOCYST

Similar to Isospora belli except for four sporocysts with two sporozoites in each.
SPECIMEN OF CHOICE: Fecal specimen, looking for oocyst.

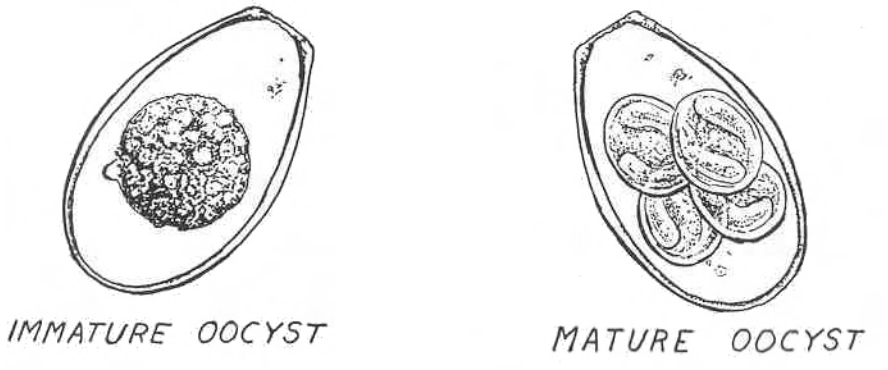



Figure 2-8. Eimeria species.

## ORGANISM 3--Cryptosporidium species

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Normally a parasite in the intestines of reptiles, birds, and mammals other than man; increasing number of human cases, causing severe diarrhea mostly in immunosuppressed persons.
HABITAT: Intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Mammals.
INFECTIVE FORM: Mature oocyst.
MODE OF INFECTION: Ingestion.
LABORATORY IDENTIFICATION:
SPECIMEN OF CHOICE: Feces.

## Cryptosporidium species (continued)

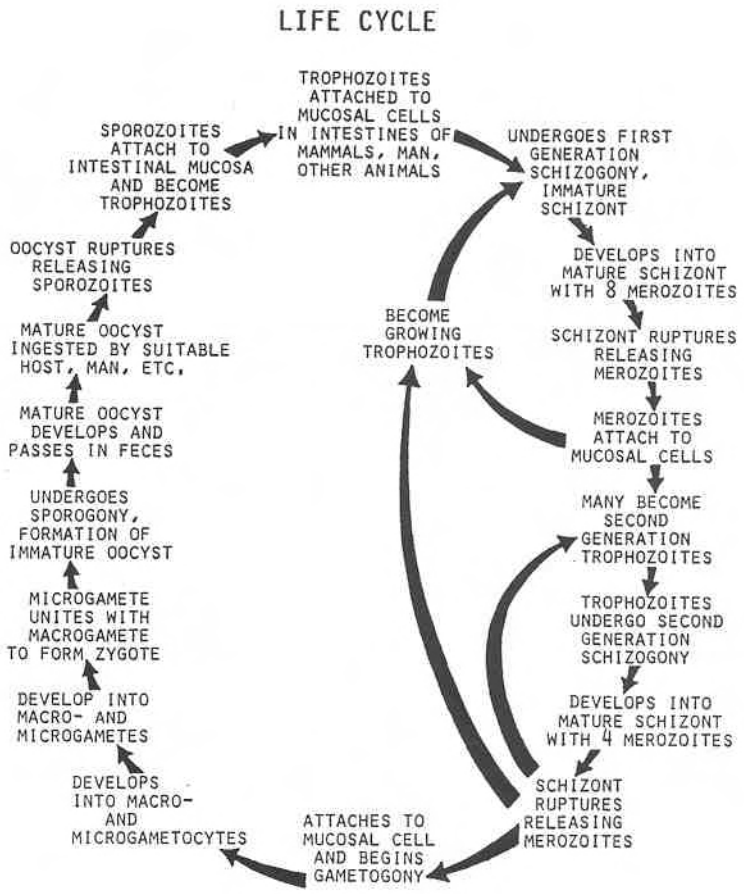

LIFE CYCLE
TROPHOZOITES ATTACHED TO MUCOSAL CELLS IN INTESTINES OF MAMMALS, MAN, OTHER ANIMALS
UNDERGOES FIRST GENERATION SCHIZOGONY, IMMATURE SCHIZONT
DEVELOPS INTO MATURE SCHIZONT WITH 8 MEROZOITES
SCHIZONT RUPTURES RELEASING MEROZOITES
MEROZOITES ATTACH TO MUCOSAL CELLS
MANY BECOME SECOND GENERATION TROPHOZOITES
TROPHOZOITES UNDERGO SECOND GENERATION SCHIZOGONY
DEVELOPS INTO MATURE SCHIZONT WITH 4 MEROZOITES
SCHIZONT RUPTURES RELEASING MEROZOITES
ATTACHES TO MUCOSAL CELL AND BEGINS GAMETOGONY
DEVELOPS INTO MACRO- AND MICROGAMETOCYTES
DEVELOP INTO MACRO- AND MICROGAMETES
MICROGAMETE UNITES WITH MACROGAMETE TO FORM ZYGOTE
UNDERGOES SPOROGONY, FORMATION OF IMMATURE OOCYST
MATURE OOCYST DEVELOPS AND PASSES IN FECES
MATURE OOCYST INGESTED BY SUITABLE HOST, MAN, ETC.
OOCYST RUPTURES RELEASING SPOROZOITES
SPOROZOITES ATTACH TO INTESTINAL MUCOSA AND BECOME TROPHOZOITES
BECOME GROWING TROPHOZOITES

Figure 2-9. Life cycle of Cryptosporidium species.

MATURE OOCYST

SIZE: 2 to 4 mcm.
SHAPE: Spherical.
CONTENTS: Four sporozoites.
Visible cyst wall.

Figure 2-10. Oocyst of Cryptosporidium.

## ORGANISM 4--Toxoplasma gondii

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: 30 to 90 percent human infection; acquired: asymptomatic, rarely a severe systemic disease; congenital: acute or chronic; implicated as one of the leading causes of birth defects; primarily diagnosed serologically.
HABITAT: Intracellular parasite; infects any nucleated cell of the body; intestinal epithelium (initially) in felines only: predominance in brain and retina.
INTERMEDIATE HOST: Humans and many other mammals; cats and other felines are definitive hosts.
RESERVOIR HOST: Cats and other domestic animals (reservoirs for human infection).
INFECTIVE FORM: Infective oocysts from cat feces; or tissue trophozoites or cysts.
MODE OF INFECTION: Ingestion of oocysts; spread by the blood; placental penetration; ingestion of raw or poorly cooked meat.
LABORATORY IDENTIFICATION:
SPECIMEN OF CHOICE: Blood, tissue biopsy.

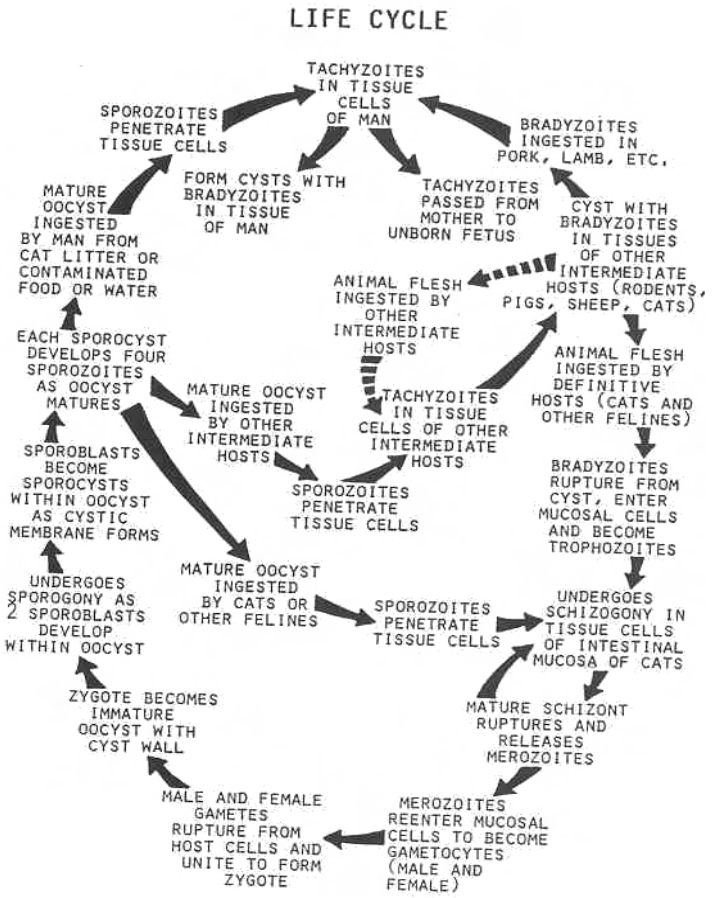
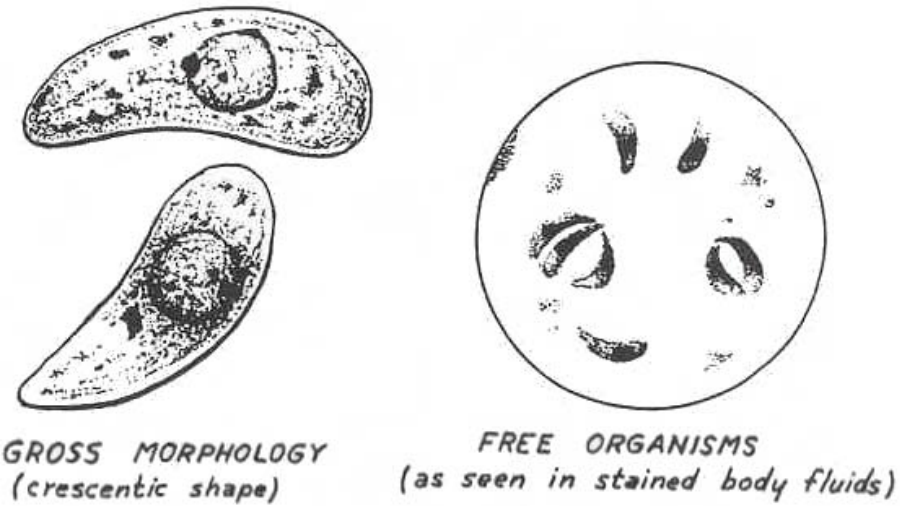

LIFE CYCLE
TACHYZOITES IN TISSUE CELLS OF MAN
SPOROZOITES PENETRATE TISSUE CELLS
BRADYZOITES INGESTED IN PORK, LAMB, ETC.
FORM CYSTS WITH BRADYZOITES IN TISSUE OF MAN
TACHYZOITES PASSED FROM MOTHER TO UNBORN FETUS
CYST WITH BRADYZOITES IN TISSUES OF OTHER INTERMEDIATE HOSTS (RODENTS, PIGS, SHEEP, CATS)
MATURE OOCYST INGESTED BY MAN FROM CAT LITTER OR CONTAMINATED FOOD OR WATER
ANIMAL FLESH INGESTED BY OTHER INTERMEDIATE HOSTS
EACH SPOROCYST DEVELOPS FOUR SPOROZOITES AS OOCYST MATURES
MATURE OOCYST INGESTED BY OTHER INTERMEDIATE HOSTS
TACHYZOITES IN TISSUE CELLS OF OTHER INTERMEDIATE HOSTS
ANIMAL FLESH INGESTED BY DEFINITIVE HOSTS (CATS AND OTHER FELINES)
SPOROBLASTS BECOME SPOROCYSTS WITHIN OOCYST AS CYSTIC MEMBRANE FORMS
SPOROZOITES PENETRATE TISSUE CELLS
BRADYZOITES RUPTURE FROM CYST, ENTER MUCOSAL CELLS AND BECOME TROPHOZOITES
UNDERGOES SPOROGONY AS 2 SPOROBLASTS DEVELOP WITHIN OOCYST
MATURE OOCYST INGESTED BY CATS OR OTHER FELINES
SPOROZOITES PENETRATE TISSUE CELLS
UNDERGOES SCHIZOGONY IN TISSUE CELLS OF INTESTINAL MUCOSA OF CATS
ZYGOTE BECOMES IMMATURE OOCYST WITH CYST WALL
MATURE SCHIZONT RUPTURES AND RELEASES MEROZOITES
MALE AND FEMALE GAMETES RUPTURE FROM HOST CELLS AND UNITE TO FORM ZYGOTE
MEROZOITES REENTER MUCOSAL CELLS TO BECOME GAMETOCYTES (MALE AND FEMALE)

Figure 2-11. Life cycle of Toxoplasma gondii.

Toxoplasma gondii (Continued)

TACHYZOITES

ACUTE STAGES (GROUPS): Contains 8-16 tachyzoites (Giemsa stain) per infected cell.
SIZE: 3 x 6 mcm; crescent-shaped.
RED, Central nucleus.




CYST

SIZE: 200 to 1000 mcm.
BRADYZOITES: thousands per cyst; size--6 mcm.

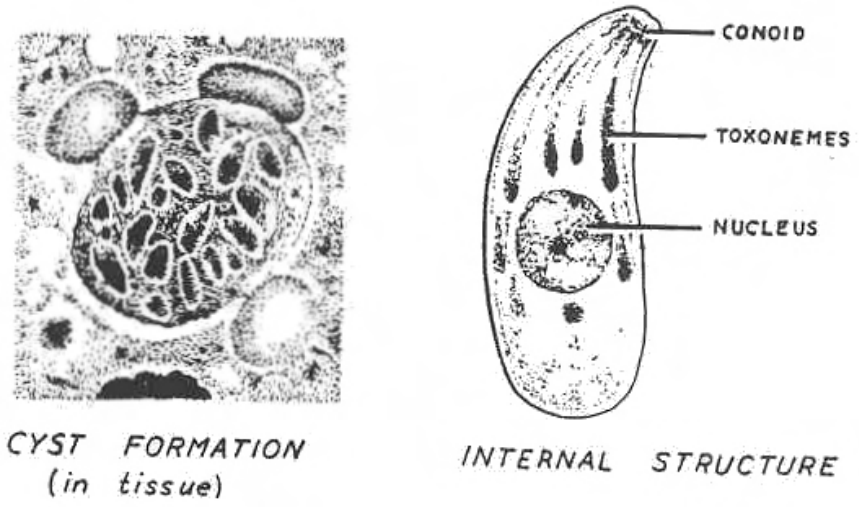



Figure 2-12. Stages of Toxoplasma gondii.

## ORGANISM 5--Sarcocystis hominis (lindermanii)

### GENERAL CHARACTERISTICS

(Proposed from comparable species in laboratory animals)

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Usually a mild disease.
HABITAT: Muscle; intestinal tract.
INTERMEDIATE HOST: Usually herbivores.
RESERVOIR HOST: Carnivores.
INFECTIVE FORM: Cystozoites or sporozoites.
MODE OF INFECTION: Ingestion.
LABORATION IDENTIFICATION:
SPECIMEN OF CHOICE: Tissue biopsies.

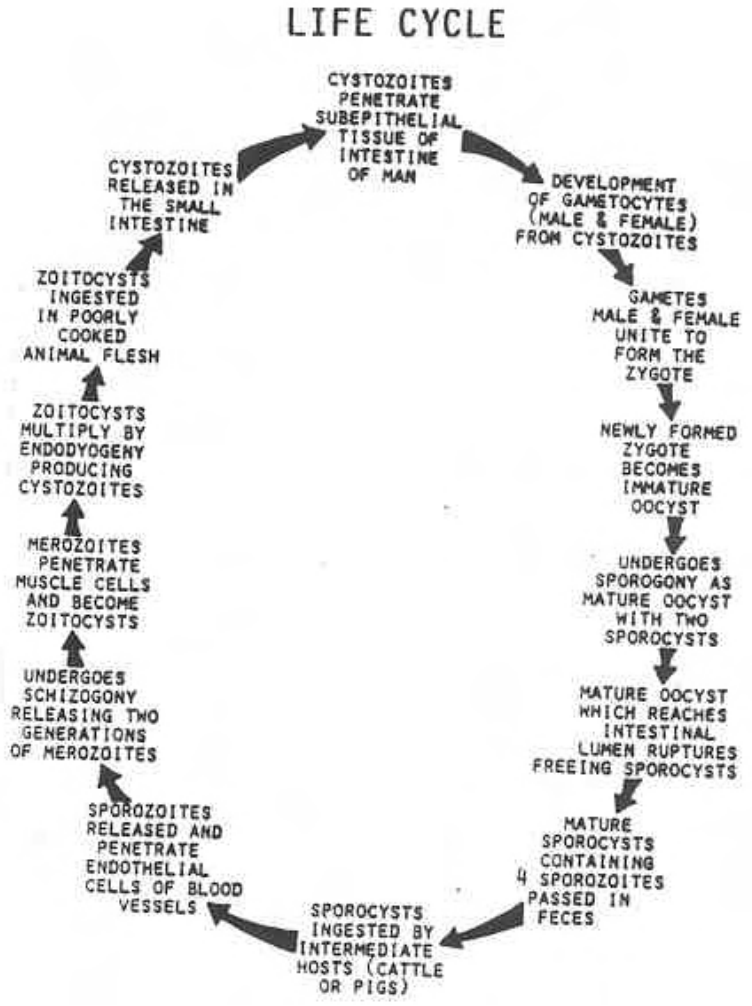

LIFE CYCLE
CYSTOZOITES PENETRATE SUBEPITHELIAL TISSUE OF INTESTINE OF MAN
DEVELOPMENT OF GAMETOCYTES (MALE & FEMALE) FROM CYSTOZOITES
GAMETES MALE & FEMALE UNITE TO FORM THE ZYGOTE
NEWLY FORMED ZYGOTE BECOMES IMMATURE OOCYST
UNDERGOES SPOROGONY AS MATURE OOCYST WITH TWO SPOROCYSTS
MATURE OOCYST WHICH REACHES INTESTINAL LUMEN RUPTURES FREEING SPOROCYSTS
MATURE SPOROCYSTS CONTAINING 4 SPOROZOITES PASSED IN FECES
SPOROCYSTS INGESTED BY INTERMEDIATE HOSTS (CATTLE OR PIGS)
SPOROZOITES RELEASED AND PENETRATE ENDOTHELIAL CELLS OF BLOOD VESSELS
UNDERGOES SCHIZOGONY RELEASING TWO GENERATIONS OF MEROZOITES
MEROZOITES PENETRATE MUSCLE CELLS AND BECOME ZOITOCYSTS
ZOITOCYSTS MULTIPLY BY ENDODYOGENY PRODUCING CYSTOZOITES
ZOITOCYSTS INGESTED IN POORLY COOKED ANIMAL FLESH
CYSTOZOITES RELEASED IN THE SMALL INTESTINE

Figure 2-13. Life cycle of Sarcocystis hominis.

## Sarcocystis hominis (lindermanii) (continued)

ZOITOCYST (SARCOCYST)

SIZE: Usually 1 to 2 mm; may be as big as 1 cm.
SHAPE: Elongate; cylindrical; spindle-shape.
CONTENTS: Internal septae and compartments full or cystozoites.
LIMITING MEMBRANE: With radial striations.

Figure 2-14. Zoitocyst S. hominis.

## ORGANISM 6--Pneumocystis carinii

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Causes interstitial plasma cell pneumonia usually in infants and immunocompromised persons.
HABITAT: Lungs.
INTERMEDIATE HOST: None.
RESERVOIR HOSTS: Rodents, a variety of animals.
INFECTIVE FORM: Mature cyst.
MODE OF INFECTION: Air-borne sputum particles inhaled, transplacental.
LABORATORY IDENTIFICATION:
SPECIMEN SOURCE: Pulmonary material; bronchial washings; biopsies.
SPECIAL TECHNIQUES: Giemsa's stain; methenamine silver nitrate, Gram-Weigert.

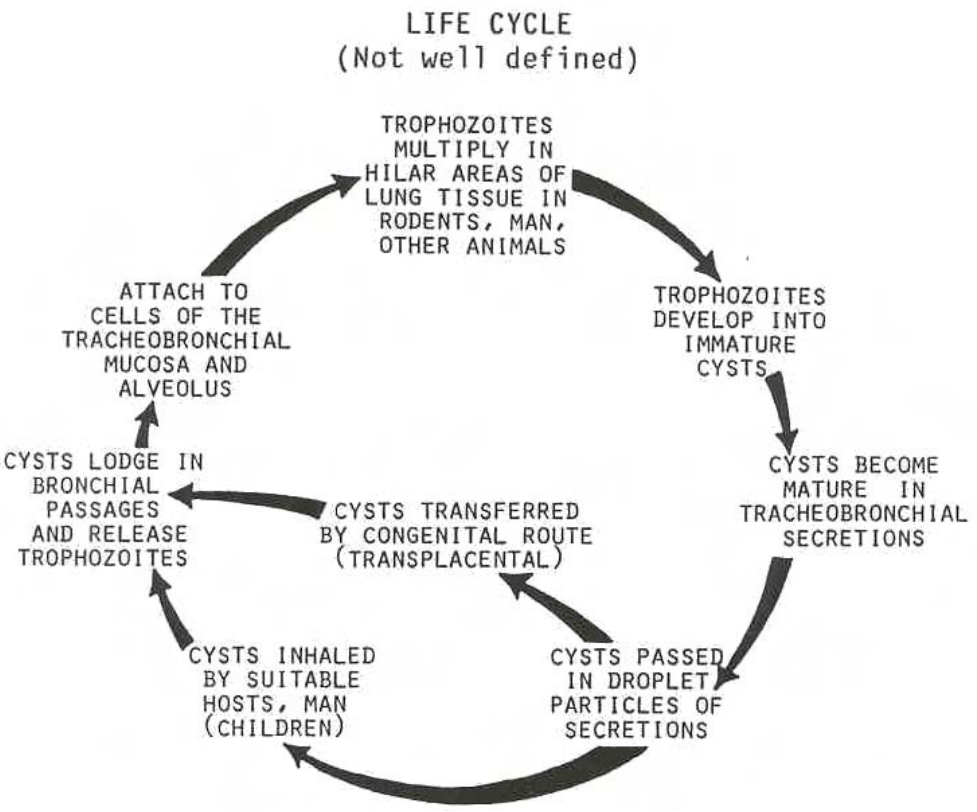
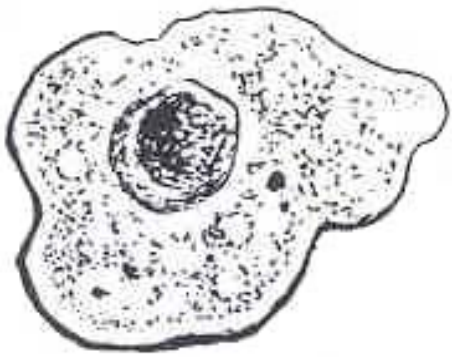

LIFE CYCLE
(Not well defined)
TROPHOZOITES MULTIPLY IN HILAR AREAS OF LUNG TISSUE IN RODENTS, MAN, OTHER ANIMALS
TROPHOZOITES DEVELOP INTO IMMATURE CYSTS
CYSTS BECOME MATURE IN TRACHEOBRONCHIAL SECRETIONS
CYSTS PASSED IN DROPLET PARTICLES OF SECRETIONS
CYSTS INHALED BY SUITABLE HOSTS, MAN (CHILDREN)
CYSTS TRANSFERRED BY CONGENITAL ROUTE (TRANSPLACENTAL)
CYSTS LODGE IN BRONCHIAL PASSAGES AND RELEASE TROPHOZOITES
ATTACH TO CELLS OF THE TRACHEOBRONCHIAL MUCOSA AND ALVEOLUS

Figure 2-15. Life cycle of Pneumocystis carinii.

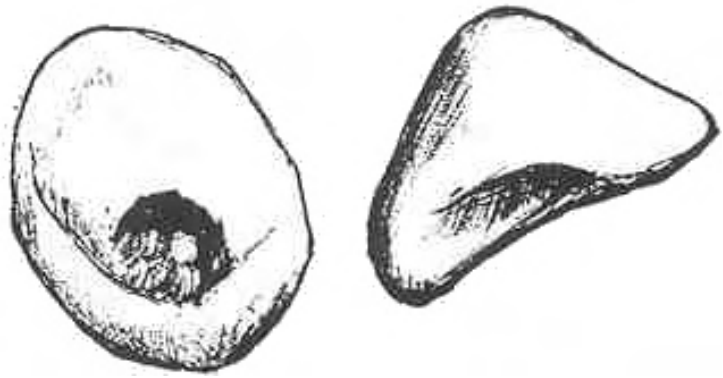
TROPHOZOITE

SIZE: 2 to 4 mcm.
SHAPE: Irregular.
CONTENTS: Central nucleus.



IMMATURE CYST

SIZE: 5 to 12 mcm.
SHAPE: Spherical, often collapsed.



MATURE CYST

SIZE: 5 to 12 mcm.
SHAPE: Spherical.
CONTENTS: 8 nuclei, often in "rosette" arrangement.

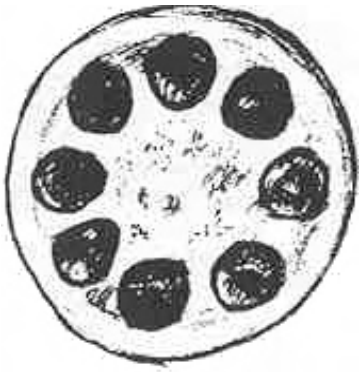


Figure 2-16. Stages of P. carinii.

## ORGANISM 7--Plasmodium species

### GENERAL CHARACTERISTICS

HISTORY: Symptoms described by 1550 BC (Ebers papyrus); recovery of Countess d'El Chinchon 1623 to 1632); associated with "bad (mal) swamp air" (aria); Laveran described the parasite in 1880 AD.

COMMON NAME

Plasmodium vivax--Benign tertian malaria.
Plasmodium ovale--Ovale tertian malaria.
Plasmodium malariae--Quartan malaria.
Plasmodium falciparum--Malignant tertian malaria.

PATHOGENESIS: Cyclic fever and chills; aches and general malaise.

Plasmodium vivax: Usually mild; parasitemia up to five percent; 47 percent of reported cases; relapses due to recurring liver phases (secondary exoerythrocytic); fever cycle (chills) are every 45 hours (average).

Plasmodium ovale: Usually mild; parasitemia less than one percent; less than one percent of reported cases; questionable relapses; fever cycle is 49 hours (average).

Plasmodium malariae: Usually mild (severe kidney involvement in children, may be fatal); parasitemia up to one percent; less than three percent of reported cases; longest incidence of recrudescence (up to 30 years); fever cycle is 72 hours.

Plasmodium falciparum: Usually severe (blocking of capillaries, involvement of major organs, algid malaria, black water fever, drug resistant strains have been recognized); parasitemia up to 40 percent; 49 percent of total reported cases; short recrudesent relapse with no secondary exoerythrocytic phases; fever cycle is 36 to 48 hours, often asynchronous.

GEOGRAPHICAL DISTRIBUTION

P. vivax--Temperate and tropic zones.
P. ovale--Mainly Africa and western Pacific islands.
P. malariae and P. falciparum--Tropics and subtropics.

TREATMENT

MALARIOUS ATTACK: Chloroquine and Amodiaquine are very effective drugs for rapid relief (no effect against the exoerythrocytic phase); Pyrimethamine and Chlorquanide are slow but can eradicate tissue stages of P. falciparium.

SUPPRESSION (PREVENTION OR POSTPONEMENT OF ATTACKS): Chloroquin e, Amodiaquine, Pyrimethamine, and Chlorquanide destroy the erythrocytic parasite; Primaquine is effective against gametocytes and exoerythrocytic parasites.

PROPHYLAXIS: P. falciparum--pyrimethamine and primaquine: Black water fever; corticosteroids: Resistant strains of P. falciparum; quinine, Fansidar and Mefloquine.

## Plasmodium species (continued)

CONTROL: Eradication of the vector (female Anopheles mosquito); elimination of source (reservoir host and asymptomatic carriers).
PROPHYLAXIS: Prevent mosquito bites and drug prophylaxis.
DIRECT TRANSMISSION: Screen blood donor and pregnant female.
HABITAT IN MAN: Liver and blood.
INTERMEDIATE HOST: Man is the intermediate host; the mosquito is the definitive host.
RESERVOIR HOST: Primate.
INFECTIVE FORM: To man is the sporozoite; to mosquitoes are both macrogametocytes and microgametocytes.
MODE OF INFECTION: Injection.

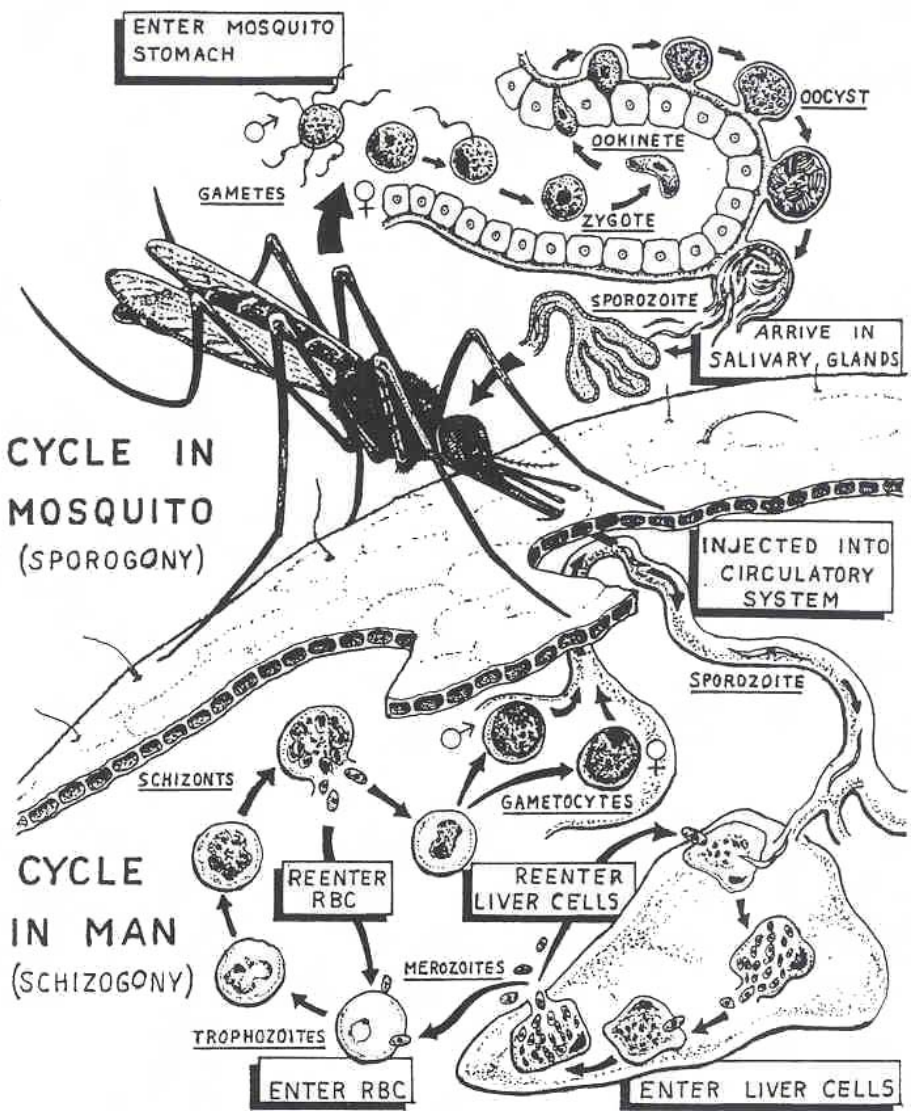



Figure 2-17. Life cycle of Plasmodium species.

## Plasmodium species (continued)

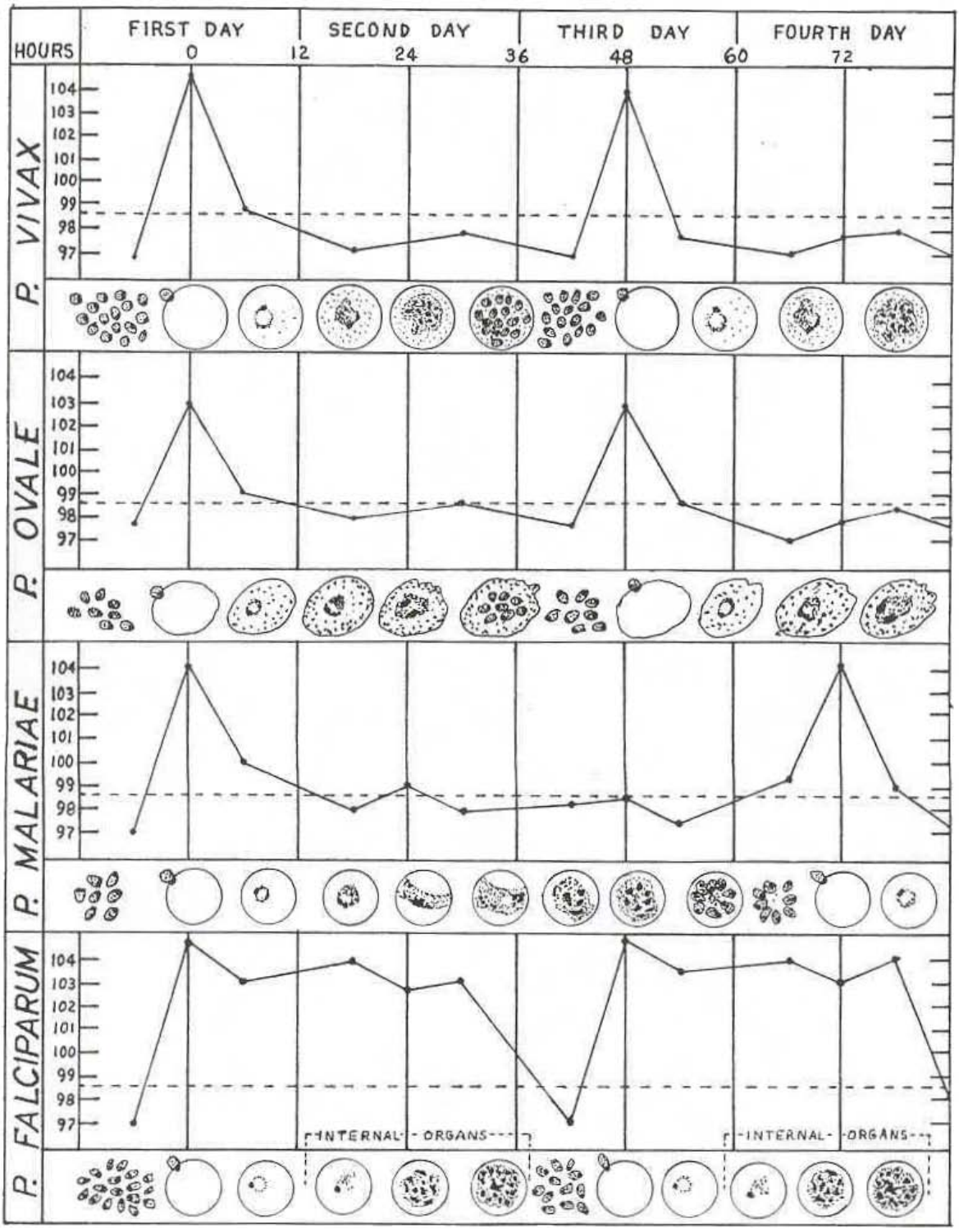



Figure 2-18. Correlation of the fever-chill cycles and erythrocytic cycles of the human Plasmodi.

## Plasmodium species (continued)

YOUNG TROPHOZOITES--RING FORMS

SPECIMEN OF CHOICE: Capillary blood.

TIME OF COLLECTION: About 8 to 12 hours after the fever peak and about 8 to 12 hours intervals thereafter (midway between the fever peaks results in clearly defined morphology.

REPORT AS PLASMODIUM SPECIES: Unless 5 or more young rings per oil immersion field without Schuffner's granules are present: this case represents P. falciparum (thin smear only).

CHROMATIN DOT: Small; magenta-red.

CYTOPLASM: Light blue; 1 to 3 mcm in size.

HEMOZOIN PIGMENT: Usually absent.

INFECTED ERYTHROCYTE: May be macrocytic and pale with Schuffner's granules in cases of P. vivax and P. ovale.

**NOTE**: See Figures 1-1, 2-1, and 4-1 in Appendix C for additional illustrations.

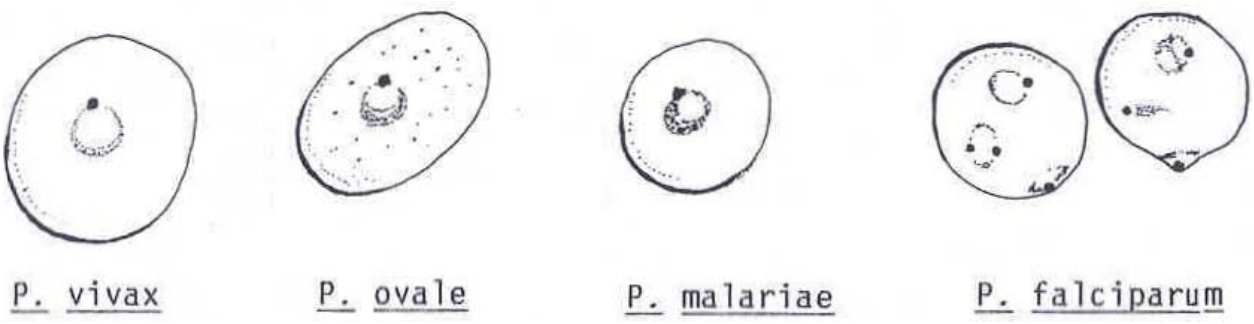


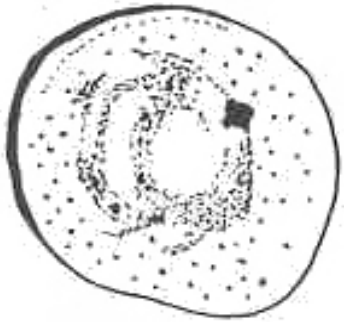

Figure 2-19. Ring forms of Plasmodia.

**Plasmodium species (continued)**

GROWING TROPHOZOITES

P. vivax

CHROMATIN MASS: Small to medium; light magenta.
CYTOPLASM
COLOR: Light blue.
DENSITY: Flimsy; amoeboid shape.
SIZE--8 to 10 mcm; spreads out through the erythrocyte.
VACUOLES: Multiple.
HEMOZOIN PIGMENT: Diffused; light gold rods.
INFECTED ERYTHROCYTE: Enlarged; pale; fine Schuffner's granules.



P. ovale

CHROMATIN MASS--Medium to large; dark magenta.
CYTOPLASM
COLOR--Darker blue than P. vivax.
Density--Slight amoeboid activity.
SIZE--4 to 7 mcm; less than half of erythrocyte filled.
VACUOLES--May have one to two.
HEMOZOIN PIGMENT--Golden brown; often diffused.
INFECTED ERYTHROCYTE--Slightly enlarged; pale Schuffners granules appear early; may be oval and/or fimbriated

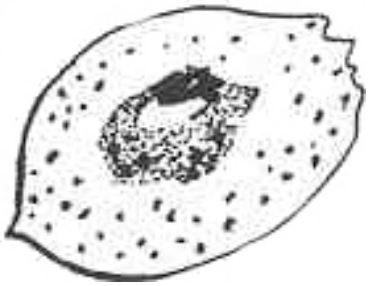


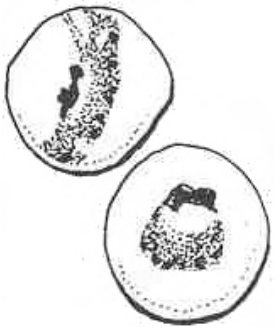
Figure 2-20. Growing trophozoite s, Plasmodium. (continued)

## Plasmodium species (continued)

P. malariae

CHROMATIN MASS: Medium to large; dark magenta.
CYTOPLASM
COLOR: Darker blue.
DENSITY: Band forms; basket forms.
SIZE: 4 to 7 mcm.
VACUOLES: May have multiple.
HEMOZOIN PIGMENT: Dark brown.
INFECTED ERYTHROCYTE: Normal appearance; may be slightly microcytic.

**NOTE**: See Figures 1-3, 2-2, 2-3, 3-1 in Appendix C for additional illustrations.



P. falciparum

CHROMATIN MASS: Very small; some with double masses; applique forms common; magenta.
CYTOPLASM
COLOR: Blue.
DENSITY: Delicate; flame shapes common.
SIZE: 2 to 4 mcm.
HEMOZOIN PIGMENT: Dark brown; usually not seen.
INFECTED ERYTHROCYTE: Normal appearance.

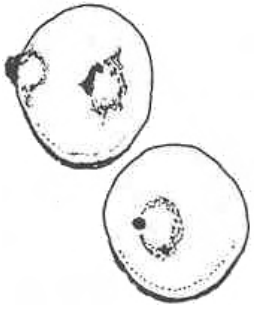


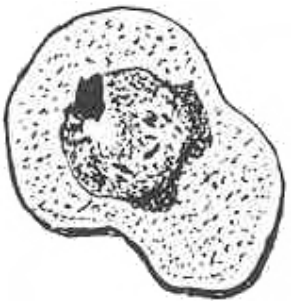
Figure 2-20. Growing trophozoite s, Plasmodium. (concluded)

**Plasmodium species (continued)**

MATURE TROPHOZOITE

P. vivax

CHROMATIN MASS: Small to medium.
CYTOPLASM
COLOR: Light blue.
DENSITY: Somewhat amoeboid.
SIZE: 8 to 10 mcm; more condensed than growing trophozoite.
VACUOLES: Usually one.
HEMOZOIN PIGMENT: Diffused; light, golden brown rods.
INFECTED ERYTHROCYTE: Enlarged; pale; even-size Schuffner's granules numerous.



P. ovale

CHROMATIN MASS: Medium to large.
CYTOPLASM
COLOR: Darker blue.
DENSITY: Compact.
SIZE: 5 to 7 mcm.
VACUOLE: Singular.
HEMOZOIN PIGMENT: Gold; somewhat diffused.
INFECTED ERYTHROCYTE: Slightly enlarged; pale; coarse and uneven Schuffner's granules; may be oval and/or fimbriate.

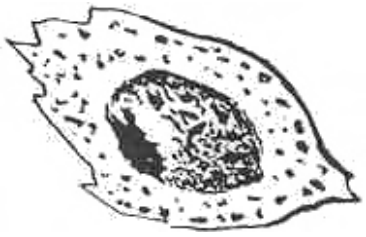
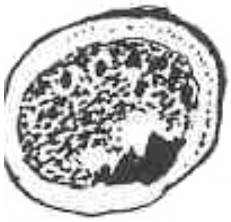


Figure 2-21. Mature trophozoite Plasmodium. (continued)

## Plasmodium species (continued)

P. malariae

CHROMATIN MASS--Medium to large.
CYTOPLASM
COLOR--Darker blue.
DENSITY--Compact.
SIZE: 4 to 7 mcm.
VACUOLE: Singular; may have multiple.
HEMOZOIN PIGMENT--Dark green; coarse; usually on the edge of the parasite; abundant.
INFECTED ERTHYROCYTE: Normal appearance (often slightly microcytic).



P. falciparum

Normally not found in the peripheral circulatory system except in high parasitemia.

CHROMATIN MASS: Small.
CYTOPLASM:
COLOR: Blue.
DENSITY: Slightly compact.
SIZE: 2 to 4 mcm.
VACUOLE: Singular.
HEMOZOIN PIGMENT: Black; one or two clumps.
INFECTED ERTHYROCYTE: Normal appearance.

Figure 2-21. Mature trophozoite Plasmodium. (concluded)

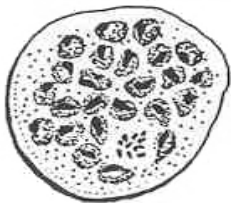
**NOTE**: See Figures 1-4, 2-4, 3-4 and 4-4 in Appendix C for additional illustrations.

## Plasmodium species (continued)

MATURE SCHIZONT

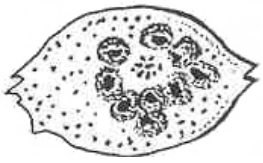
P. vivax

SIZE OF MEROZOITES: Medium.
NUMBER OF MEROZOITES: 12 to 24 mcm in random order.
SHAPE: Attempts to fill the RBC.
HEMOZOIN PIGMENT: Gold; central cluster of rods.
INFECTED ERYTHROCYTE: Enlarged; pale; Schuffner's granules.



P. ovale

SIZE OF MEROZOITES: Medium-large.
NUMBER OF MEROZOITES: 4 to 16 mcm in random order.
SHAPE: Fills one-half of the RBC.
HEMOZOIN PIGMENT: Gold; central cluster.
INFECTED ERYTHROCYTE: Enlarged; pale; Schuffner's granules.



P. malariae

SIZE OF MEROZOITES: Medium-large.
NUMBER OF MEROZOITES: 6 to 12 mcm, usually in rosette arrangement.
SHAPE: Fills the RBC.
HEMOZOIN PIGMENT: Dark green;central cluster of granules.
INFECTED ERYTHROCYTE: Normal.

Figure 2-22. Mature schizonts, Plasmodium. (continued)

## Plasmodium species (continued)

P. falciparum

Rarely seen, poor prognosis.
SIZE OF MEROZOITES: Very small.
NUMBER OF MEROZOITES: 8 to 32 mcm in random order.
SHAPE: Fills about 1/2 of the RBC.
HEMOZOIN PIGMENT: Black; peripheralclump.
INFECTED ERYTHROCYTE: Normal.

Figure 2-22. Mature schizonts, Plasmodium. (concluded)

**NOTE**: See Figures 1-6, 2-6, 3-6 in Appendix C for additional illustrations.

GAMETOCYTES

DIFFERENTIATION: No vacuoles present.
MACROGAMETOCYTE: Dark blue and compact cytoplasm; peripheral and compact chromatin.
MICROGAMETOCYTE: Light blue and diffused cytoplasm; thready chromatin.

P. vivax

SHAPE: Oval.
CYTOPLASM: Pale blue.
CHROMATIN MASS: Medium to large.
SIZE: Fills the entire RBC.
HEMOZOIN PIGMENT: Gold; abundant; scattered.
INFECTED ERYTHROCYTE: Enlarged; pale; Schuffner's granules.

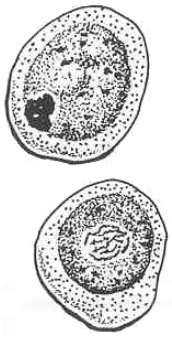
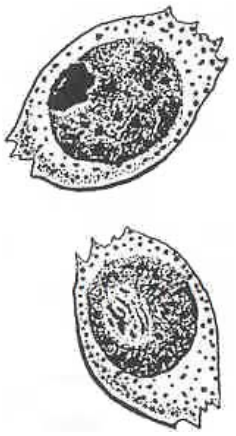


Figure 2-23. Gametocytes, Plasmodium. (continued)

## Plasmodium species (continued)

P. ovale

SHAPE: Oval.
CYTOPLASM: Dark blue.
CHROMATIN MASS: Medium-large.
SIZE: Almost fills the RBC.
HEMOZOIN PIGMENT: Gold-brown; abundant; scattered.
INFECTED ERYTHROCYTE: Enlarged; pale; Schuffner's granules.



P. malarie

SHAPE: Oval.
CYTOPLASM: Dark blue.
CHROMATIN MASS: Medium-large.
SIZE: Fills three-fourths of the RBC.
HEMOZOIN PIGMENT: Dark green;abundant; scattered.
INFECTED ERTHYROCYTE: Normal appearance.

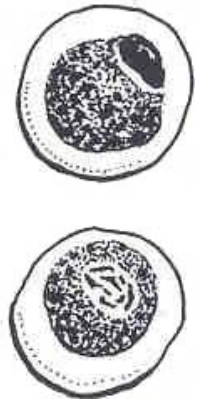


Figure 2-23. Gametocytes, Plasmodium. (continued)

## Plasmodium species (continued)

P. falciparum

SHAPE: Crescent; banana.
CYTOPLASM: Light blue.
CHROMATIN MASS: Central; fragmented.
SIZE: Longer than the RBC's diameter.
HEMOZOIN PIGMENT: Red-black; clustered about the chromatin.
INFECTED ERYTHROCYTE: Stretched; ghost cell.

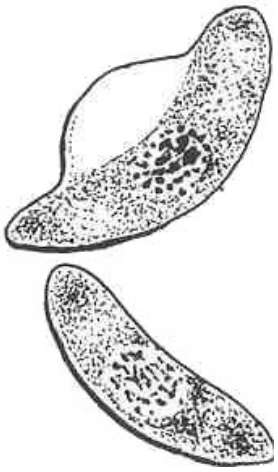


Figure 2-23. Gametocytes, Plasmodium. (concluded)

**NOTE**: See Figures 1-7, 1-8, 2-7, 2-8, 3-7, 4-6 and 4-7 in Appendix C for additional illustrations.

THICK DROP PREPARATION

SPECIATION: Most difficult to accomplish except with the gametocyte of P. falciparum,
CYTOPLASM: Scattered or fractured; blue.
CHROMATIN MASS: Red to deep magenta.
HEMOZOIN PIGMENT: Clumped,
ERYTHROCYTES: Lysed; may be seen outlined by the granules.
PROPER DENSITY OF SMEAR: 10 to 30 WBC's per oil immersion field.
FIBRIN: Only a few bluish strands are acceptable.
PROBLEMS: Confusion with other structures such as: platelets, WBCs, bacteria, cellular debris, stain crystals, and other artifacts.
PRECIPITATE: Proper rinsing and procedure should eliminate background elements.

## Plasmodium species (concluded)

1- Nuclear chromatin - red

2- Cytoplasm - blue

3- Homozoin pigment - yellow to black

4- Schuffner's granules - outline RBC

5- White blood cells

6- Platelets - light pink or red

7- Bacteria - dark staining

8- Artifacts - precipitated stain

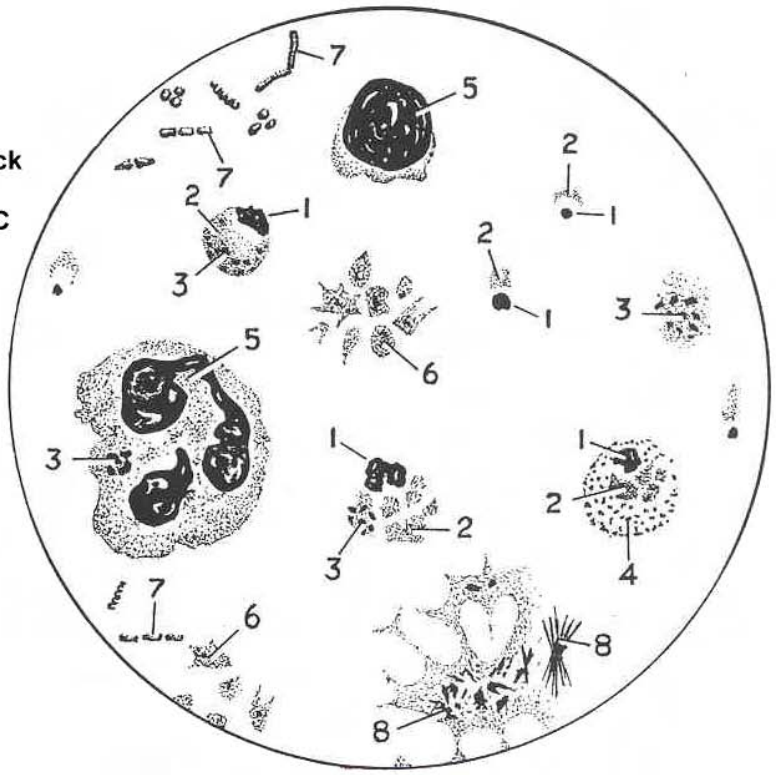


Figure 2-24. Parasite morphology on thick smear.

**Continue with Exercises**

## EXERCISES, LESSON 2

**INSTRUCTIONS:** Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Motility of Sporozoans is accomplished by:

   a. Gliding.

   b. Undulation of longitudinal ridges.

   c. Body flexion.

   d. All of the above.

2. The size of mature oocysts of Cryptosporidium is:

   a. 2 to 4 mcm.

   b. 6 to 10 mcm.

   c. 12 to 15 mcm.

   d. 12 to 30 mcm.

3. A Sporozoan organism that frequently causes birth defects in humans is:

   a. Sarcocystis hominis.

   b. Cryptosporidium.

   c. Toxoplasma gondii.

   d. Pneumocystis carinii.

4. The human infective form of all Plasmodium species is the:

    a. Macrogametocyte.

    b. Microgametocyte.

    c. Sporozoite.

    d. Trophozoite.

5. The two Plasmodium species which account for most (96alinfections are:

    a. Plasmodium vivax and Plasmodium malariae.

    b. Plasmodium falciparum and Plasmodium vivax.

    c. Plasmodium malariae and Plasmodium ovale.

    d. Plasmodium falciparum and Plasmodium malariae.

6. Members of the Class Ciliata use small hair-like structures f ormovement and for:

    a. Controlling hydrostasis.

    b. Food procurement.

    c. Protection.

    d. Diffusion.

7. If a Plasmodium trophozoite occupies most of an enlarged infect edenythrocyte it is:

    a. Plasmodium vivax.

    b. Plasmodium malariae.

    c. Plasmodium ovale.

    d. Plasmodium falciparum.

8. Hemozoin pigment in the schizont form of Plasmodium malariae is:

   a. Gold.

   b. Black.

   c. Green.

   d. Brown.

9. The reservoir host of Balantidium coli is the:

   a. Rabbit.

   b. Hog.

   c. Sheep.

   d. Monkey.

10. Crescent shape gametocytes are typical of:

   a. Plasmodium vivax.

   b. Plasmodium malariae.

   c. Plasmodium falciparum.

   d. Plasmodium ovale.

11. A well prepared thick drop smear for Plasmodium will have _____ WBC's per oil immersion field.

   a. 5-10.

   b. 10-30.

   c. 30-40.

   d. 20-50.

12. Organisms belonging to the Genus Babesia can best be described as small, multiciliate, and ameboid in shape.

    a. True.

    b. False.

13. Redwater fever is transmitted to man by:

    a. Ingestion of contaminated water.

    b. Transfusion of infected blood.

    c. Injection by hard ticks.

    d. Injection by Anopheles mosquitoes.

14. The organisms of Eimeria species, if present in the host, a rerecovered from which of the following sources?

    a. Pleural effusions.

    b. Fecal specimens.

    c. Sputum.

    d. Cerebral spinal fluid.

15. The specimen of choice for the recovery of malarial parasites is:

    a. Tissue impression smears.

    b. Venous blood.

    c. Oxalated blood.

    d. Capillary blood.

16. In the life cycle of malarial parasites, the definitive host is:

    a. Primates.

    b. Female Anopheles mosquitoes.

    c. Human beings.

    d. Domestic animals.

17. Respiration among the ciliates is accomplished by diffusion through the cell membrance

    a. True.

    b. False.

18. Infections of Isospora belli are initiated:

    a. Following the bite of the tick vector.

    b. When the oocyst is ingested by the host.

    c. Following the ingestion of mature cysts.

    d. When hosts are biten by infected sand flies.

19. Which of the following characteristics help to identify t hezoitocyst of Sarcocystis hominis?

    a. A limiting membrane with radial striations.

    b. Elongated and cylindrical shape.

    c. Internal septae and compartments.

    d. All of the above.

20. A spherical mature cyst with 8 nuclei arranged in a "rosette" pattern relates to which of the following organisms?

    a. Pneumocystis carinii.

    b. Toxoplasma gondii.

    c. Crytosporidium species.

    d. Sarcocystic hominis.

21. Both asexual and sexual reproductive cycles are known to occur among members of the class Sporozo.

    a. True.

    b. False.

22. The term used to describe the asexual cycle of members of the family Plasmodiidae is:

    a. Gametogony.

    b. Sporogony.

    c. Schizogony.

    d. None of the above.

**Check Your Answers on Next Page**

**SOLUTIONS TO EXERCISES, LESSON 2**

1. d (para 2-7)
2. a (para 2-11, org 3)
3. c (para 2-11, org 4)
4. c (para 2-11, org 7)
5. b (para 2-11, org 7)
6. b (para 2-1)
7. a (para 2-11, figure 2-20)
8. c (para 2-11, figure 2-22)
9. b (para 2-3), org 1)
10. c (para 2-11, figure 2-23)
11. b (Figure 2-24
12. b (para 2-4)
13. c (para 2-6), org 1)
14. a (para 2-11, org 2)
15. d (para 2-11, org 7)
16. b (para 2-11, org 7)
17. a (para 2-2)
18. b (para 2-11, org 1)
19. d (para 2-11, org 5)
20. a (para 2-11, org 6)
21. a (para 2-7)
22. c (para 2-10)

**End of Lesson 2**

## LESSON ASSIGNMENT

| | |
|---|---|
| **LESSON 3** | Phylum Platyhelminths. |
| **LESSON ASSIGNMENT** | Paragraphs 3-1 through 3-10. |
| **LESSON OBJECTIVES** | After completing this lesson, you should be able to: |

3-1. Identify the general characteristics of members of Phylum Platyhelminthes.

3-2. Identify the organism characteristics of parasitic members of Class Trematoda.

3-3. Select a statement that best describes the life cycle of a member of Class Trematoda.

3-4. Identify the organism characteristics of parasitic members of Class Cestoda.

3-5. Select a statement that best describes the life cycle of a member of Class Cestoda.

3-6. Identify the specimen of choice for recovery of specific Platyhelminthes.

3-7. Identify the special technique required for recovery of specific Platyhelminthes.

**SUGGESTION** After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

# LESSON 3

# PHYLUM PLATYHELMINTHS

## Section I. OVERVIEW OF PLATYHELMINTHES

### 3-1. GENERAL COMMENTS

The organisms that belong to this phylum show a dorsoventral flattening that gives them the common name of flat worms. The internal structures are organized in a bilateral symmetry. The body may consist of only one part (monozoic) or of two or more parts (polyzoic). Because flat worms are adapted to parasitism, the necessity for certain functions is no longer needed. Therefore, the organs involved in those functions were eliminated. On the other hand, with the new demands of parasitism, some of the organs have adapted to enhance their capabilities.

### 3-2. STRUCTURE

Skeletal, circulatory, and respiratory structures are lacking within these organisms. They have no body cavity (acoelomates) and the internal organs are embedded in a cellular matrix called the parenchyma. The digestive tract may be either incomplete or totally absent. The nervous system varies from a very primitive network found in the free living forms, to a well developed arrangement present in the parasitic forms, that is composed of a pair of anterior ganglia each having a longitudinal nerve cord. The excretory system varies with each species. There may be flame cells, long ducts with exterior exit, or bladders with excretory pores.

### 3-3. REPRODUCTION

With a few exceptions (for example, schistosomes), the phylum is characterized by a monoecious arrangement of the reproductive systems, in which both male and female reproductive organs are present within a single individual worm. Fertilization is internal and the exchange of spermatozoa between individuals or between two segments is the preferred method of fertilization.

### 3-4. CLASSES

There are three classes in the phylum. The class Turbellaria consists of free living organisms (for example, genus Planaria), while the classes Trematoda and Cestoda contain all parasitic species.

## Section II. CLASS TREMATODA

### 3-5. GENERAL COMMENTS

Flukes which parasitize humans have been found in most of the systems and organs of the body. Flukes use more than one host, alternating asexual generations in one or more hosts (intermediate hosts) with the sexual generation in another host (definitive host). The flukes are monozoic (one body part), leaf-shaped organisms that have two heavily muscled suckers. The oral sucker is used as a mouth while the ventral sucker, acetabulum, is used as an organ of attachment to the host. The digestive system is incomplete with internal and external digestion. The nervous system is well developed. Some anatomical structures (for example, the shape and length of the intestinal ceca, the size and location of the acetabulum, hooklets around the oral sucker, and the location, the shape, and number of testes) are used for taxonomical differentiation.

### 3-6. SUBCLASSES

The members of the class Trematoda are commonly known as flukes. The class is divided into three subclasses: Monogenea, Aspidobothria, and Digenea. The subclass Monogenea is characterized by having only one host, and its members are ectoparasites of poikilothermic vertebrates (such as fish, amphibians, and reptiles). Members of the subclass Aspidobothria are characterized by a relatively simple life cycle without asexual generations, and are ectoparasites of fish, turtles, and mollusks. The third subclass, Digenea, is the largest of the three, and encompasses all trematodes which are parasitic to man. Some members of this subclass are parasites of many other animals. The subclass Digenea is further subdivided into two orders: Strigeatoidea which contains the schistosomes, and Prosostomatea which contains the other parasitic flukes.

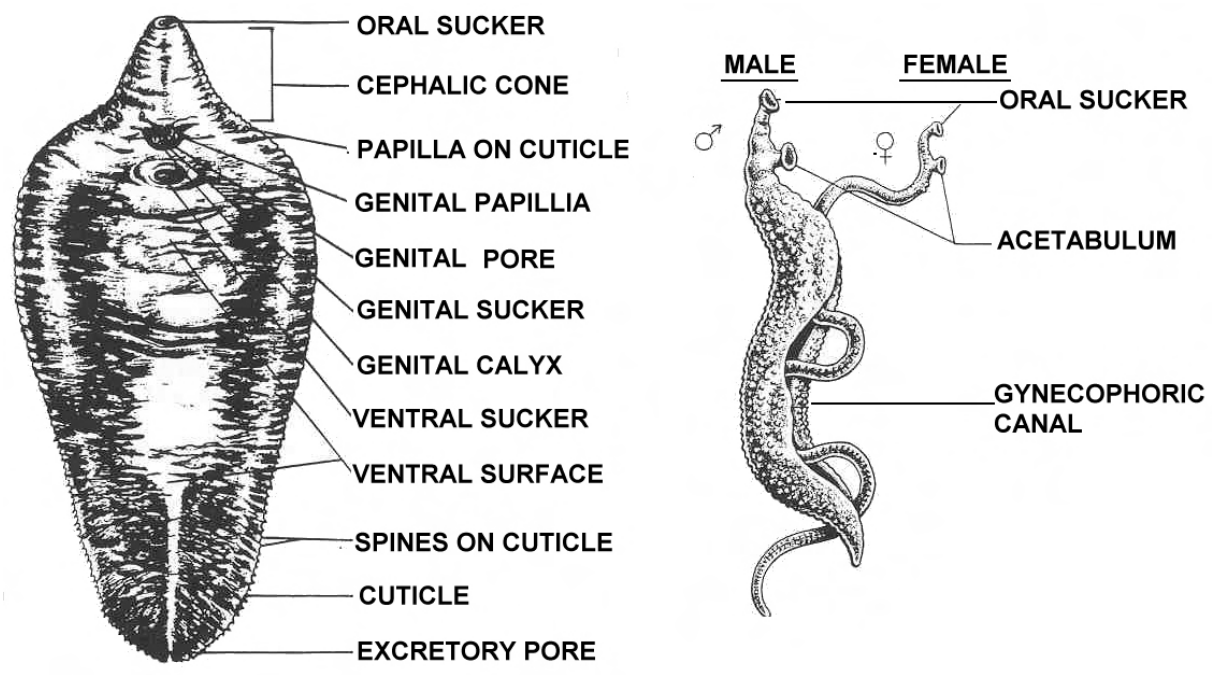



Figure 3-1. External fluke structure.

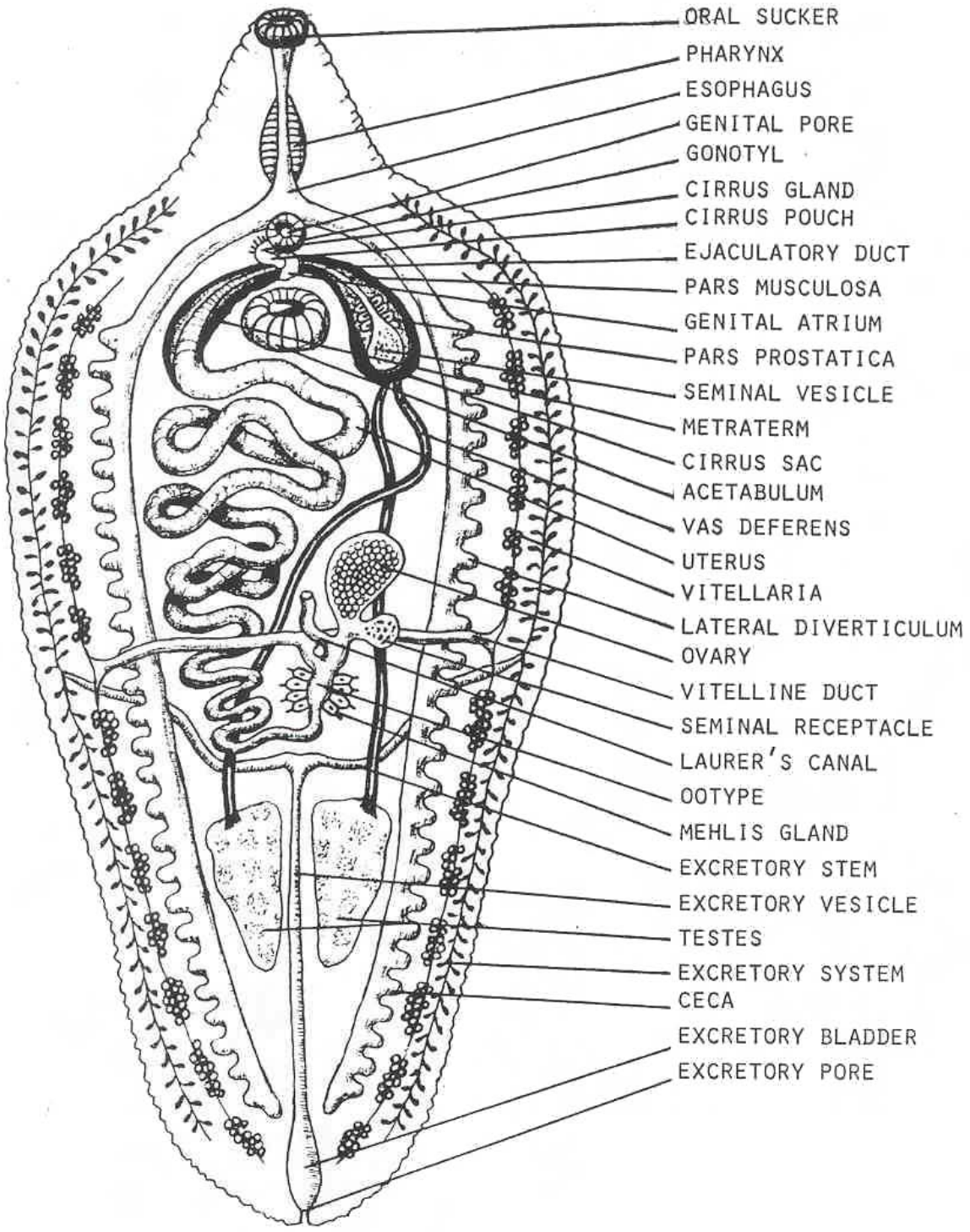



Figure 3-2. Internal fluke structure.

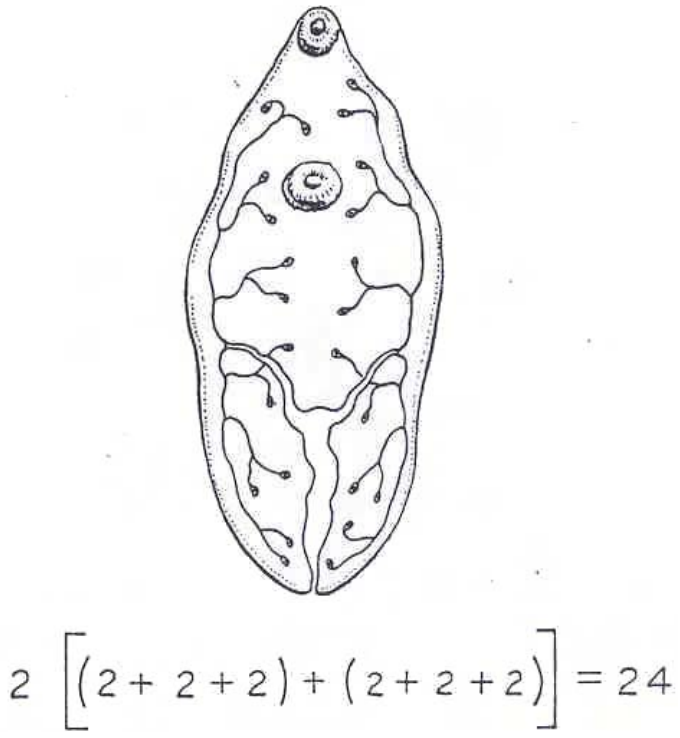



Figure 3-3. Osmoregulatory system of a fluke.

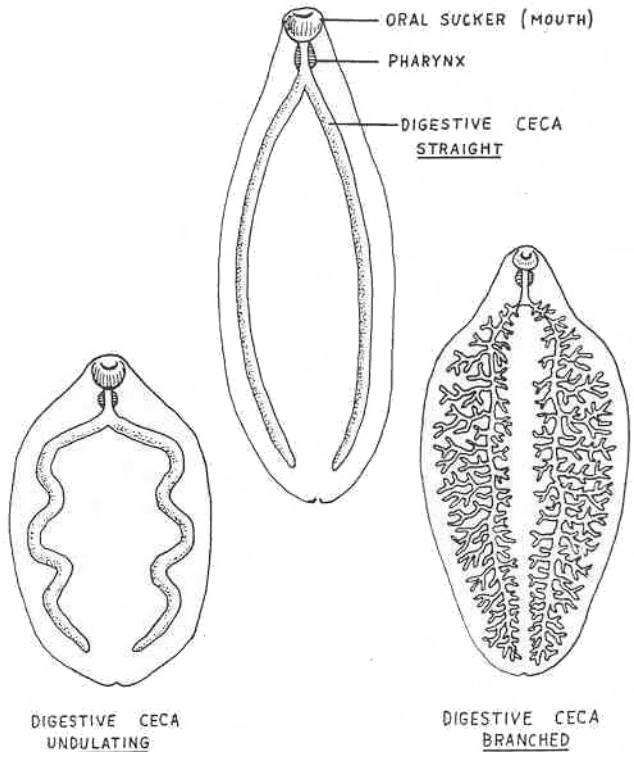



Figure 3-4. Digestive system of a fluke.

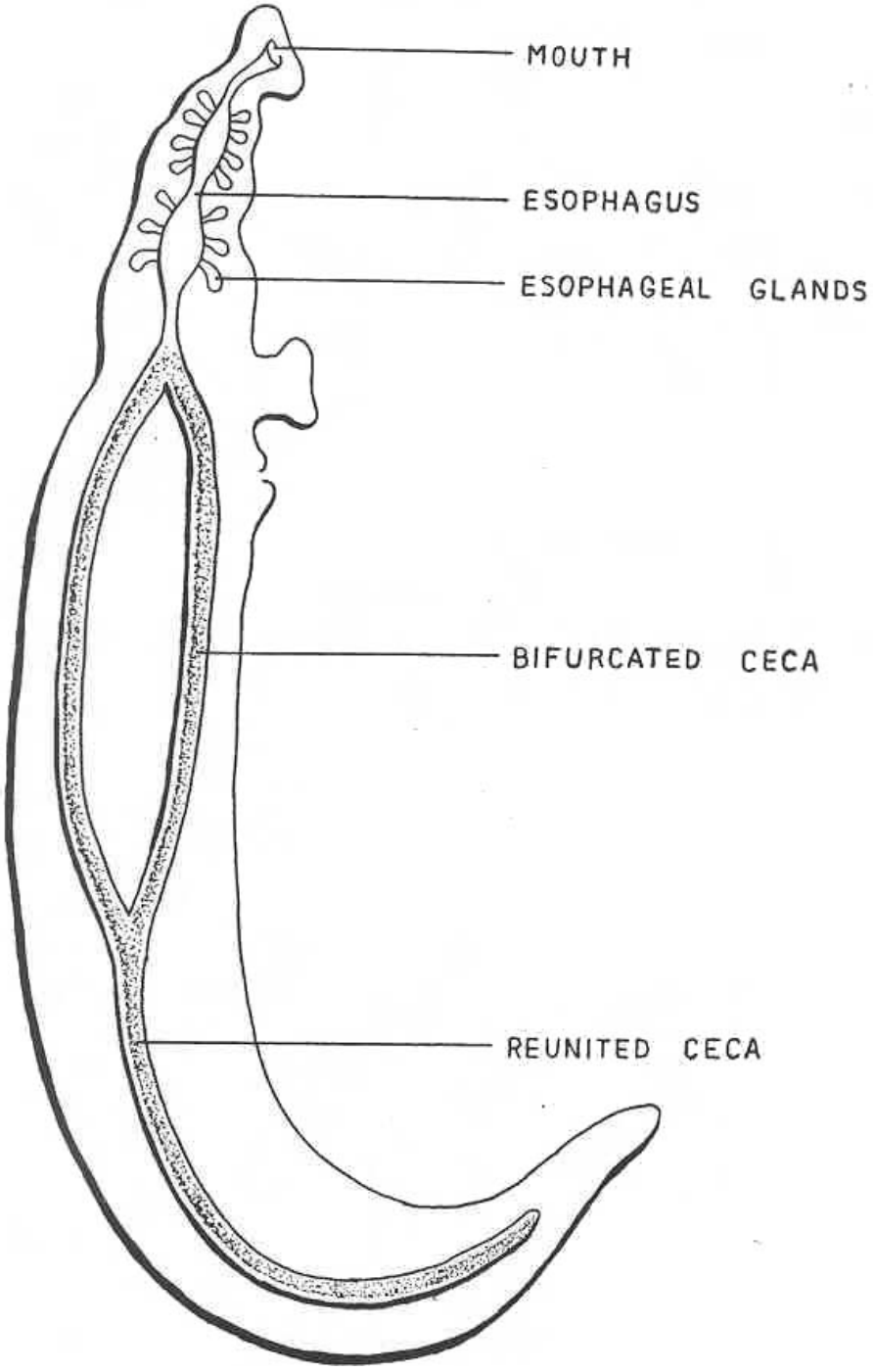



Figure 3-5. Digestive system of a fluke.

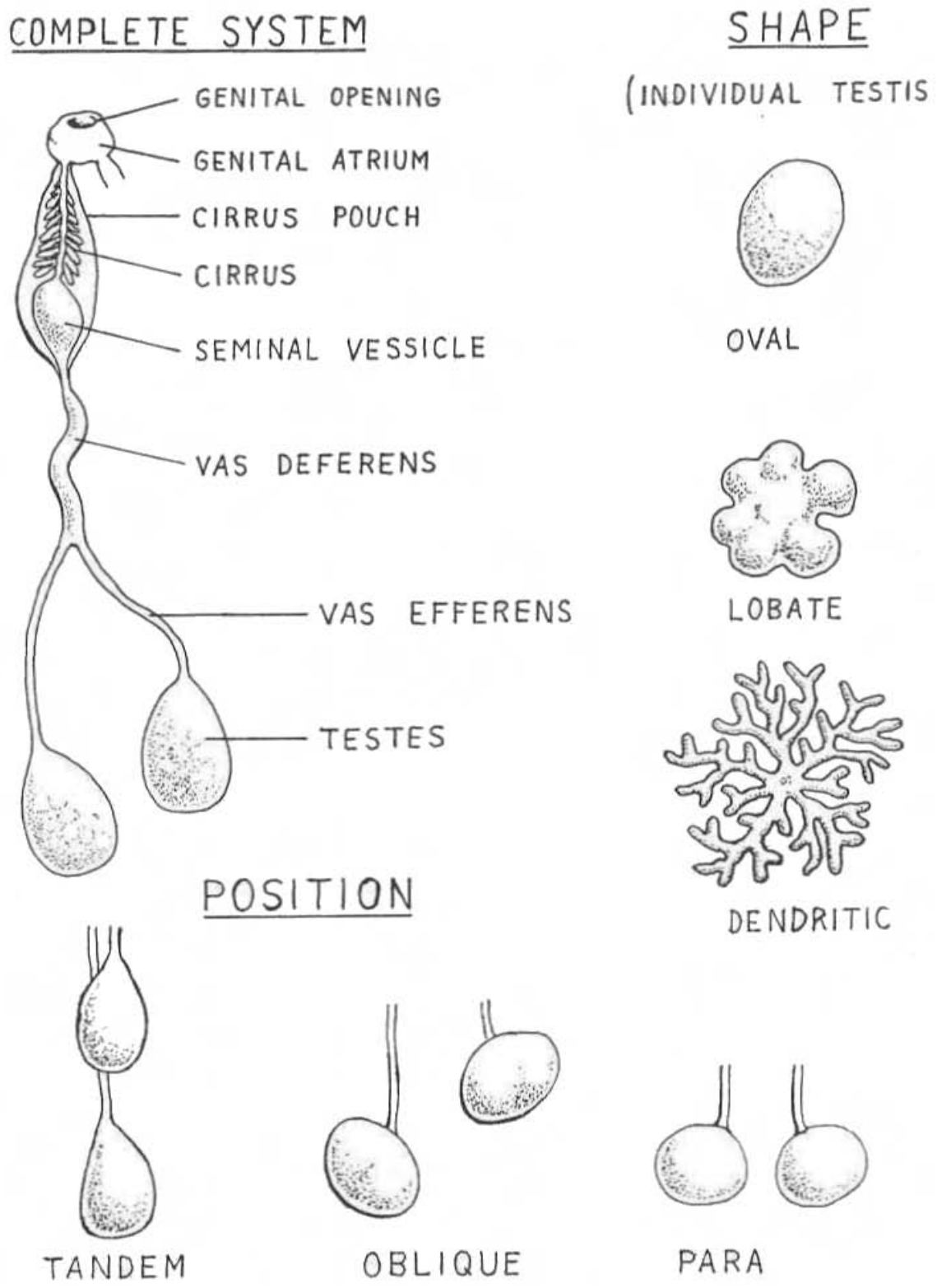



Figure 3-6. Reproductive system of a fluke--male.

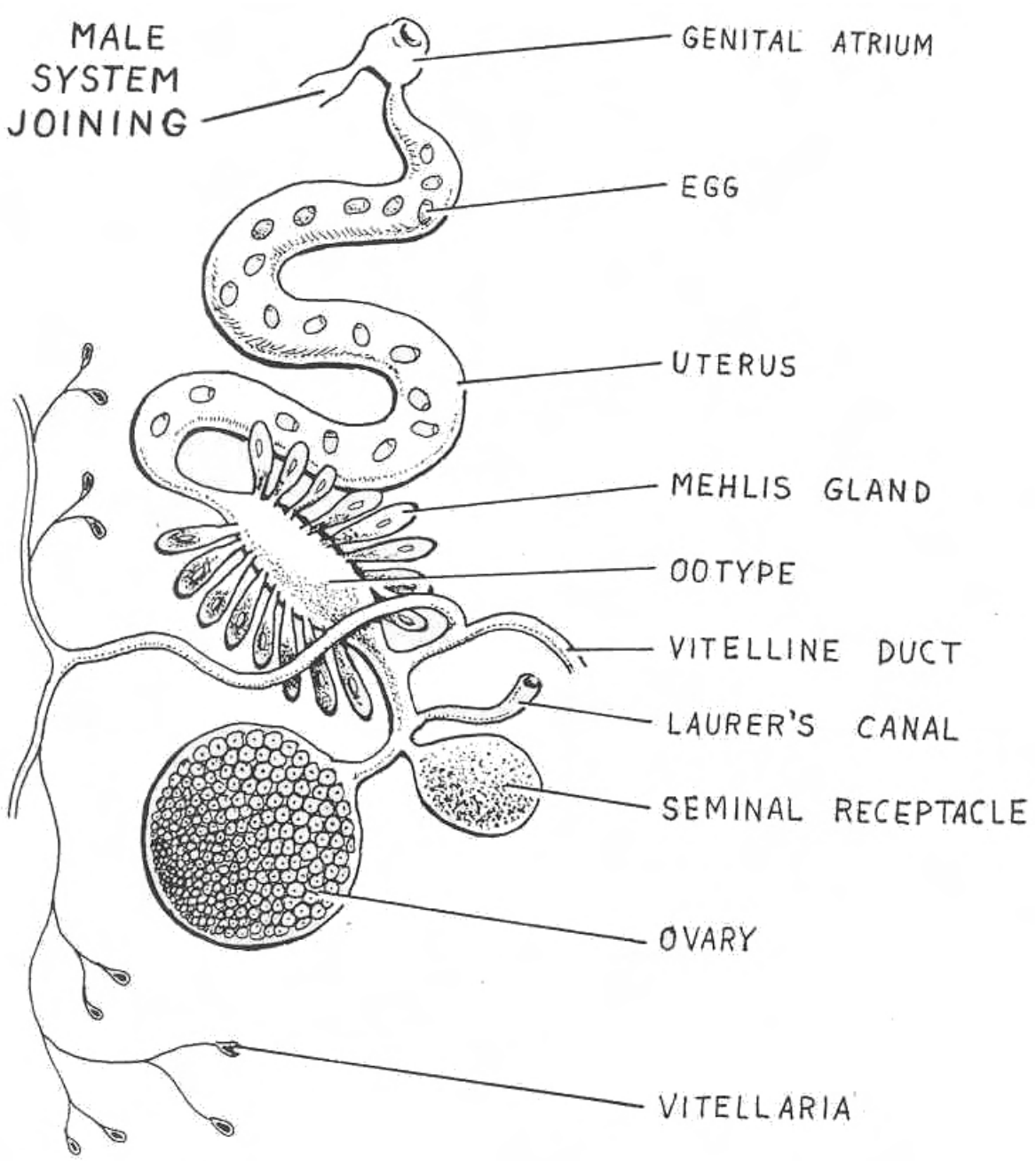



Figure 3-7. Reproductive system of a fluke--female.

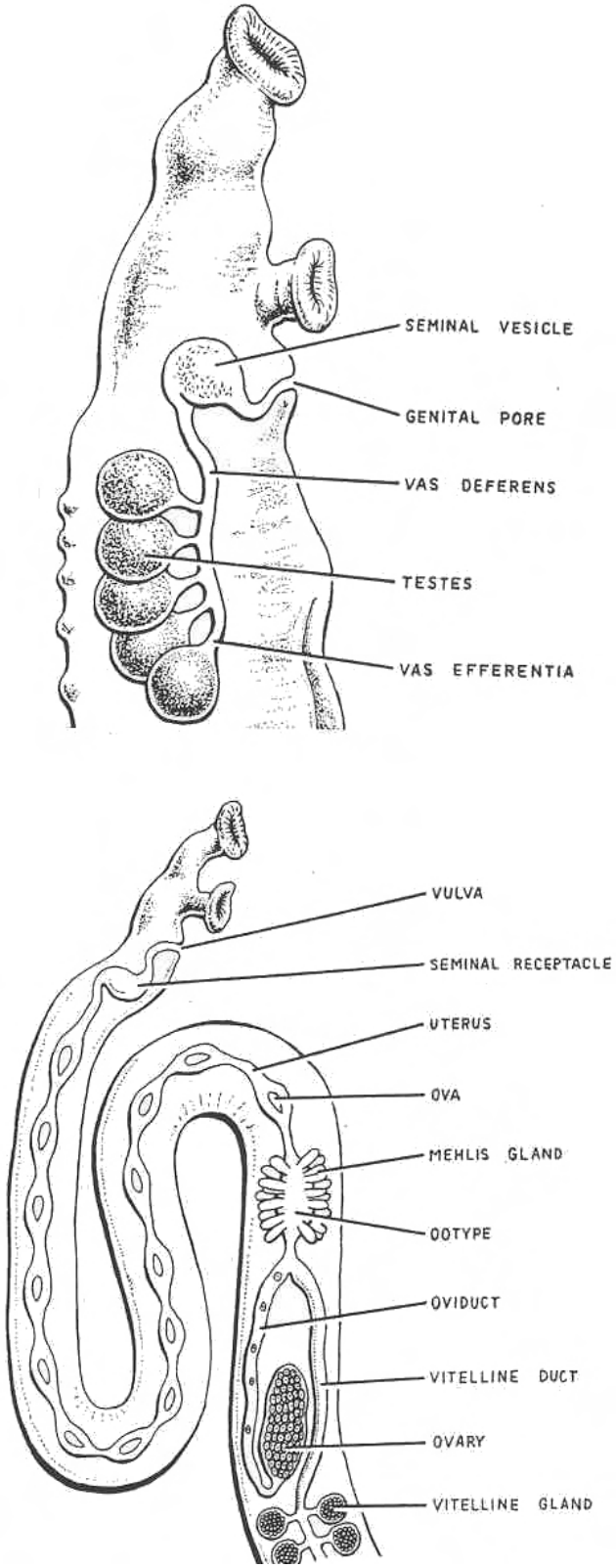



Figure 3-8. Reproductive system of schistosome.

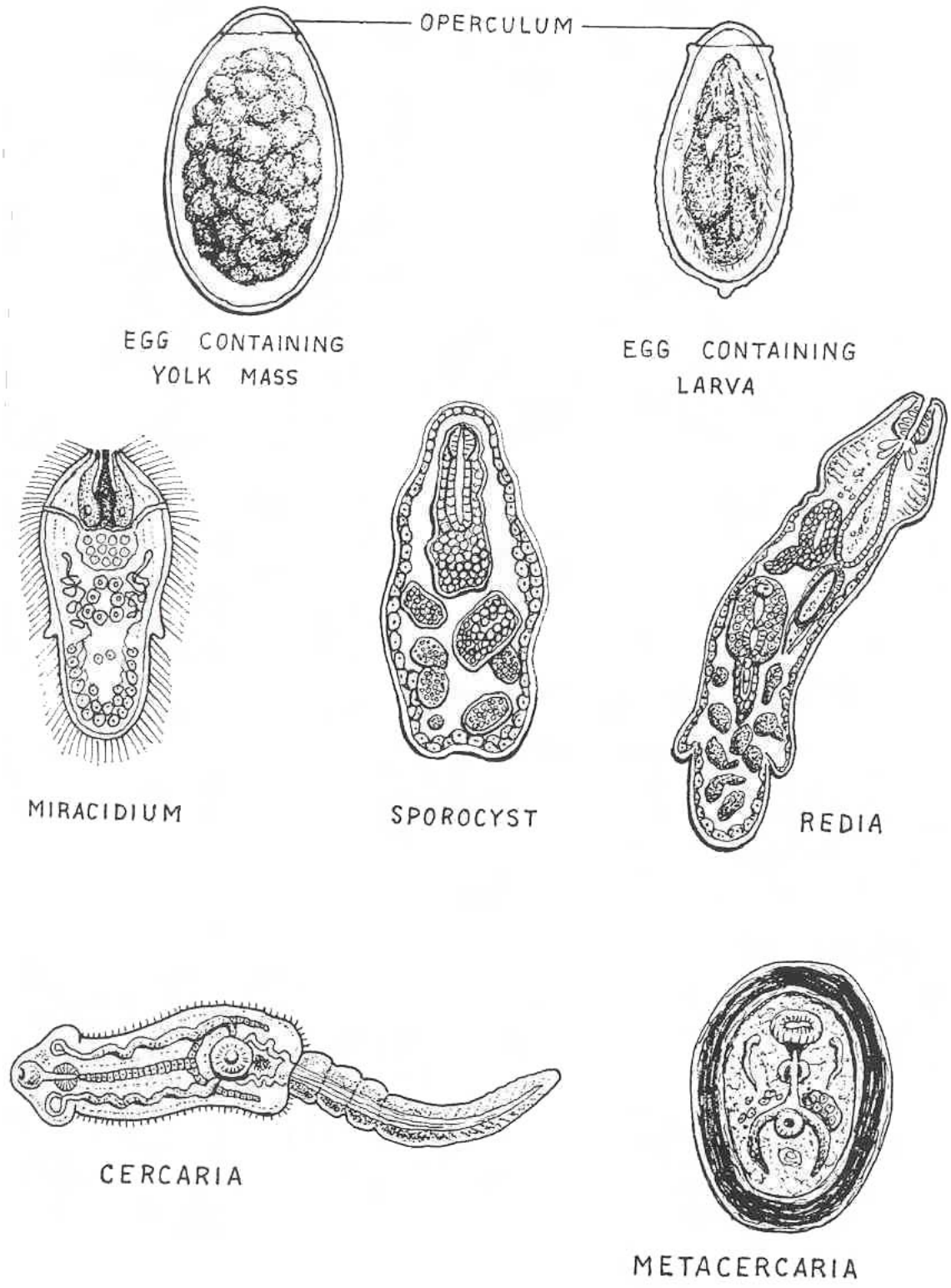



Figure 3-9. Larval stages of flukes.

**KEY TO IMPORTANT ADULT HUMAN TREMATODES**

1. Dioecious trematodes (one sex per worm)..... Schistosoma species.

   Monoecious trematodes (both sexes per worm)..... 2

2. Small flukes: size under 5 mm..... 3

   Large flukes: size range 20 to 45 mm..... 4

   Medium flukes: size range 5 to 20 mm..... 5

3. Gonotyl absent; ventral sucker offset to one side; intestinal ceca straight; testes oval and oblique..... Metagonimus yokogawai

   Gonotyl present; ventral sucker central; intestinal ceca straight; testes oval and para..... Heterophyes heterophyes

4. Cephalic cone present; intestinal ceca branched; testes tandem and dendritic..... Faciolopsis hepatica

   Cephalic cone absent; intestinal ceca undulating; testes tandem and dendritic..... Faciolopsis buski

5. Anterior testes..... 6

   Posterior testes..... 7

6. Intestinal ceca straight; testes oblique and lobate; wide acetabulum at posterior end; gourd-shaped body..... Gastrodiscoides hominis

   Intestinal ceca straight; testes oblique and lobate; Elongated..... Dicrocoelium dendriticum

7. Circlet of spines around oral sucker; intestinal ceca straight; testes tandem and lobate..... Echinostoma species

   Intestinal ceca straight; testes oblique and lobate..... Opisthorchis species

   Intestinal ceca straight; testes tandem and highly branched..... Opisthorchis sinensis

   Intestinal ceca undulating; testes para and lobate..... Paragonimus westermani

Table 3-1. Key to important adult human trematodes.

## 3-7. COMMON PARASITES OF CLASS TREMATODA

### ORGANISM 1--Schistosoma japonicum

### GENERAL CHARACTERISTICS

COMMON NAME: Oriental blood fluke
GEOGRAPHICAL DISTRIBUTION: Far East
PATHOGENESIS: Embolic eggs cause more severe lesions than other schistosome splenomegaly, cellularspecies, infiltration of vital organs; liver f ibrosis and cirrhosis, infiltration, ulceration.
HABITAT: Venules surrounding the small intestine.
INTERMEDIATE HOST
FIRST: Snail (Oncomelaria).
SECOND: None.
RESERVOIR HOST: Mammals.
INFECTIVE FORM: Cercaria.
MODE OF INFECTION: Active penetration.
SPECIMEN OF CHOICE: Feces.

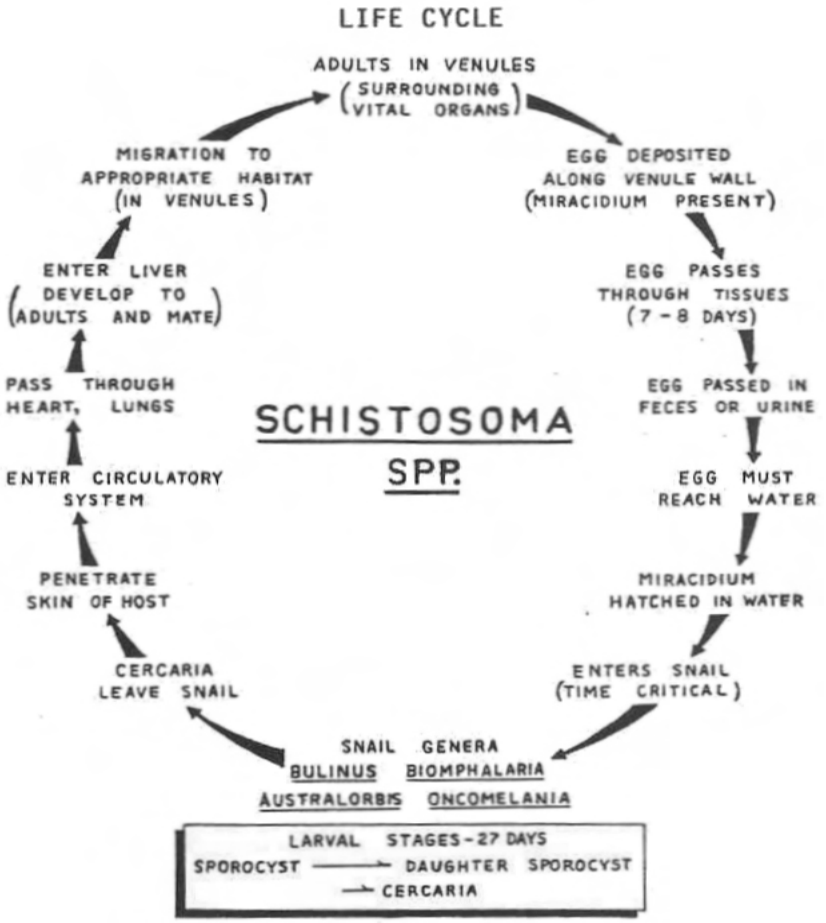
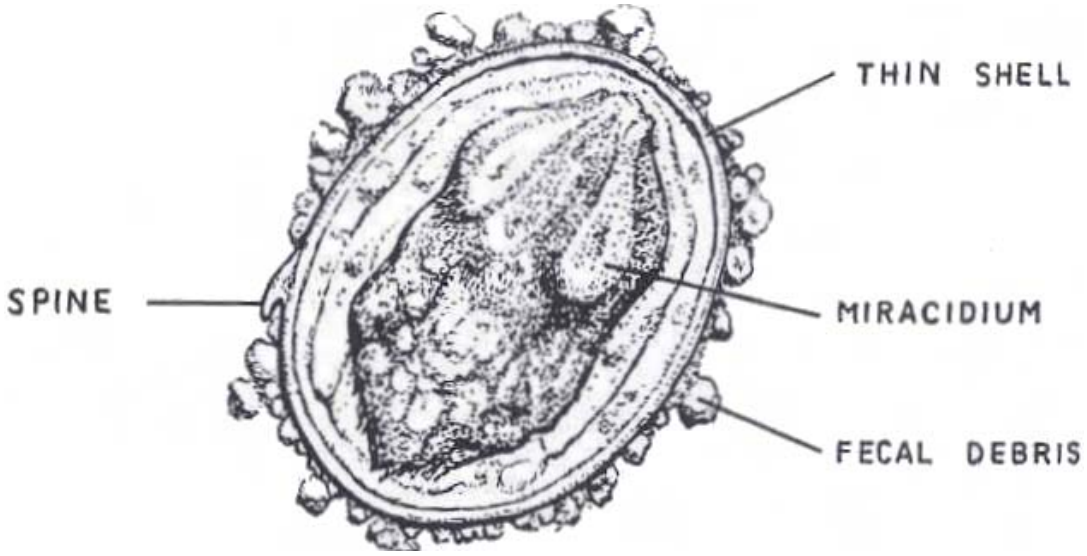

LIFE CYCLE
ADULTS IN VENULES (SURROUNDING VITAL ORGANS)
EGG DEPOSITED ALONG VENULE WALL (MIRACIDIUM PRESENT)
EGG PASSES THROUGH TISSUES (7 - 8 DAYS)
EGG PASSED IN FECES OR URINE
EGG MUST REACH WATER
MIRACIDIUM HATCHED IN WATER
ENTERS SNAIL (TIME CRITICAL)
SNAIL GENERA
BULINUS BIOMPHALARIA
AUSTRALORBIS ONCOMELANIA
CERCARIA LEAVE SNAIL
PENETRATE SKIN OF HOST
ENTER CIRCULATORY SYSTEM
PASS THROUGH HEART, LUNGS
ENTER LIVER DEVELOP TO ADULTS AND MATE
MIGRATION TO APPROPRIATE HABITAT (IN VENULES)
SCHISTOSOMA SPP.
LARVAL STAGES - 27 DAYS
SPOROCYST → DAUGHTER SPOROCYST → CERCARIA

Figure 3-10. Life cycle of Schistosoma japonicum.

## Schistosoma japonicum (Cont'd)

### OVA

SIZE: 90 x 70 mcm (medium).
SHAPE: Oval to round
COLOR: Yellow brown
OPERCULUM: Absent
CONTENT: Shouldered miracidium surrounded by vitelline membrane (double linear outline); short lateral spine sometimes curved (inconspicuous). Fecal debris adhering to shell.




### ADULTS

SIZE:
MALE: 1.0 to 2.2 cm long by 0.5 mm wide.
FEMALE: 1.2 to 2.6 cm long by 0.3 mm wide.
SHAPE: Elongated with gynecophoral canal in males.
COLOR: Greyish white
INTESTINAL CECA: Join very late (posterior third of body).
TESTES: Anterior (6 to 8)
OVARIES: Middle of body
UTERUS: Long with 50 to 100 ova.

Figure 3-11. Stages of Schistosoma japonicum. (continued)

## Schistosoma japonicum (Cont'd)

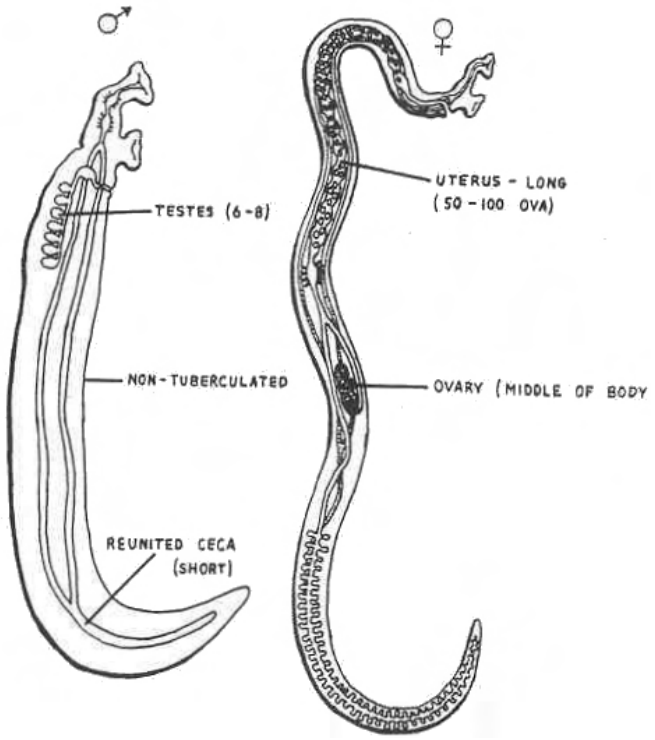



Figure 3-11. Stages of Schistosoma japonicum. (concluded)

## ORGANISM 2--Schistosoma mansoni

### GENERAL CHARACTERISTICS

COMMON NAME: Manson's blood fluke.
GEOGRAPHICAL DISTRIBUTION: Central and North Africa; Equatorial regions of South America; West Indies and Puerto Rico.
PATHOGENESIS: Infiltration of vital organs; hemorrhages, anemia, hepato-splenomegaly, liver cirrhosis, fibrous tissue proliferation, ulcerations.
HABITAT: Venules surrounding the large intestine.
INTERMEDIATE HOST
FIRST: Snail (Biomphalaria, Australorbis).
SECOND: None.
RESERVOIR HOST: Rarely monkeys.
INFECTIVE FORM: Cercaria.
MODE OF INFECTION: Active penetration.
SPECIMEN OF CHOICE: Feces.

## Schistosoma mansoni (Continued)

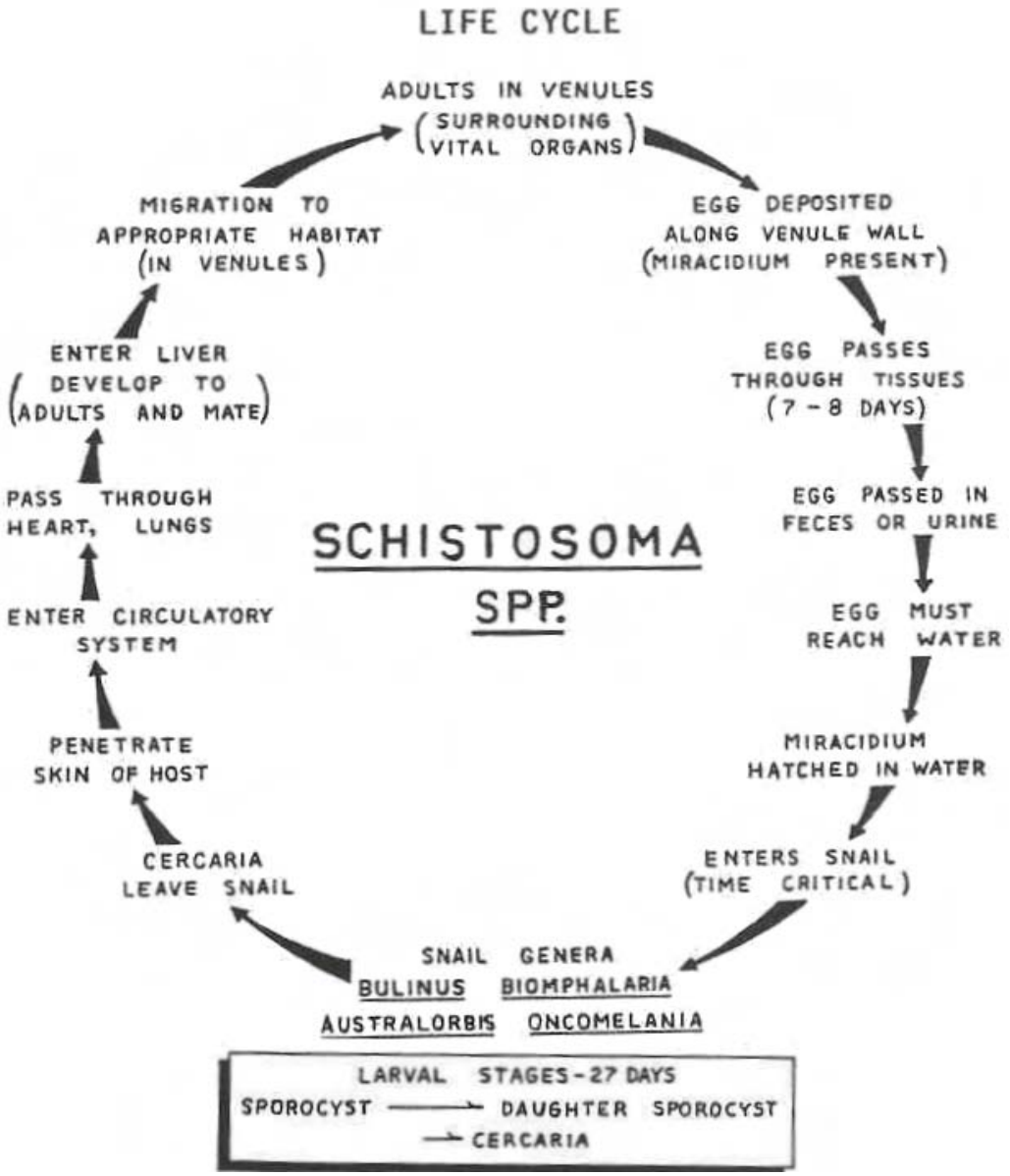
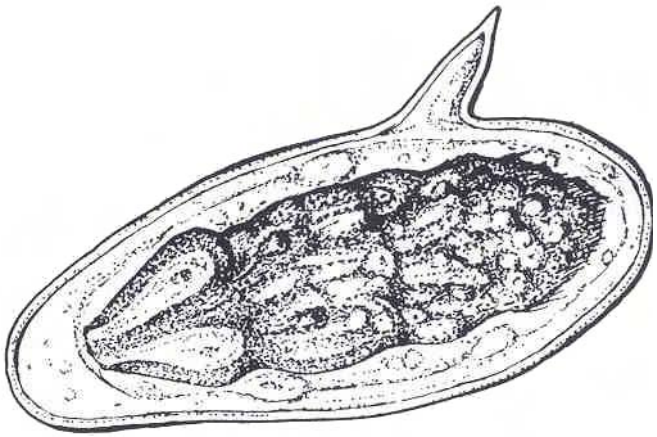

LIFE CYCLE
ADULTS IN VENULES (SURROUNDING VITAL ORGANS)
EGG DEPOSITED ALONG VENULE WALL (MIRACIDIUM PRESENT)
EGG PASSES THROUGH TISSUES (7 - 8 DAYS)
EGG PASSED IN FECES OR URINE
EGG MUST REACH WATER
MIRACIDIUM HATCHED IN WATER
ENTERS SNAIL (TIME CRITICAL)
SNAIL GENERA
BULINUS BIOMPHALARIA
AUSTRALORBIS ONCOMELANIA
CERCARIA LEAVE SNAIL
PENETRATE SKIN OF HOST
ENTER CIRCULATORY SYSTEM
PASS THROUGH HEART, LUNGS
ENTER LIVER (DEVELOP TO ADULTS AND MATE)
MIGRATION TO APPROPRIATE HABITAT (IN VENULES)
SCHISTOSOMA SPP.
LARVAL STAGES - 27 DAYS
SPOROCYST → DAUGHTER SPOROCYST → CERCARIA

Figure 3-12. Life cycle of Schistosoma mansoni.

### OVA

SIZE: 155 x 65 mcm (large).
SHAPE: Elongated.
COLOR: Yellow brown.
OPERCULUM: Absent.
CONTENT: Shouldered miracidium surrounded by vitelline membrane (double linear outline). Large lateral spine.

## Schistosoma mansoni (Cont'd)



**ADULTS**

SIZE

MALE: 0.6 to 1.4 cm long by 1.1 mm wide.
FEMALE: 1.2 to 1.6 cm long by 0.2 mm wide.

SHAPE: Elongated with gynecophoral canal in males.
COLOR: White to cream
INTESTINAL CECA: Join early (in anterior portion of body).
TESTES: Anterior (3 to 13).
OVARY: In anterior half of body.
UTERUS: Short with 1 to 5 ova.

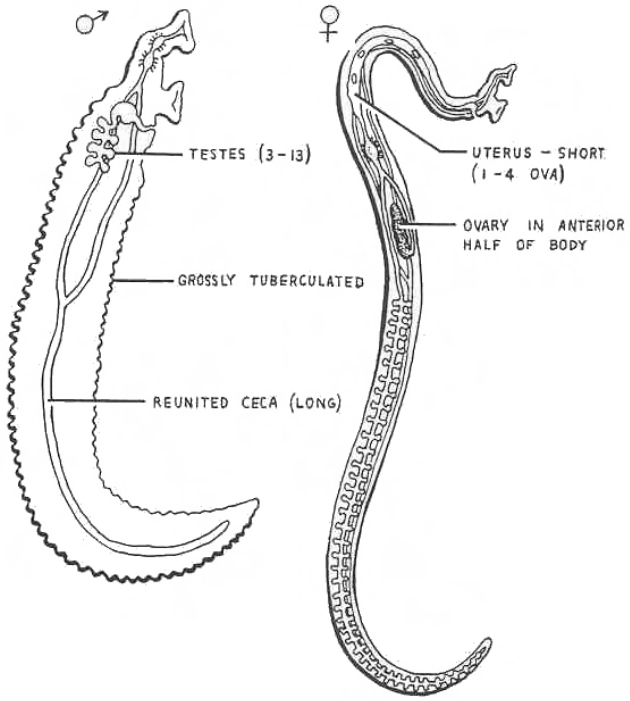



Figure 3-13. Stages of Schistosoma mansoni.

## ORGANISM 3--Schistosoma haemotobium

### GENERAL CHARACTERISTICS

COMMON NAME: Vesical blood fluke.
GEOGRAPHICAL DISTRIBUTION: Africa; Asia Minor; Mediterranean regions
PATHOGENESIS: Toxic irritations, lesions of urinary bladder and genitalia, cystitis, occlusions of ureters and urethra, hematuria, eosinophilia.
HABITAT: Venules surrounding the urinary bladder.
INTERMEDIATE HOST
FIRST: Snail (Bulinus, Biomphalaria).
SECOND: None
RESERVOIR HOST: None
INFECTIVE FORM: Cercaria
MODE OF INFECTION: Active penetration.
SPECIMEN OF CHOICE: Urine (also feces)

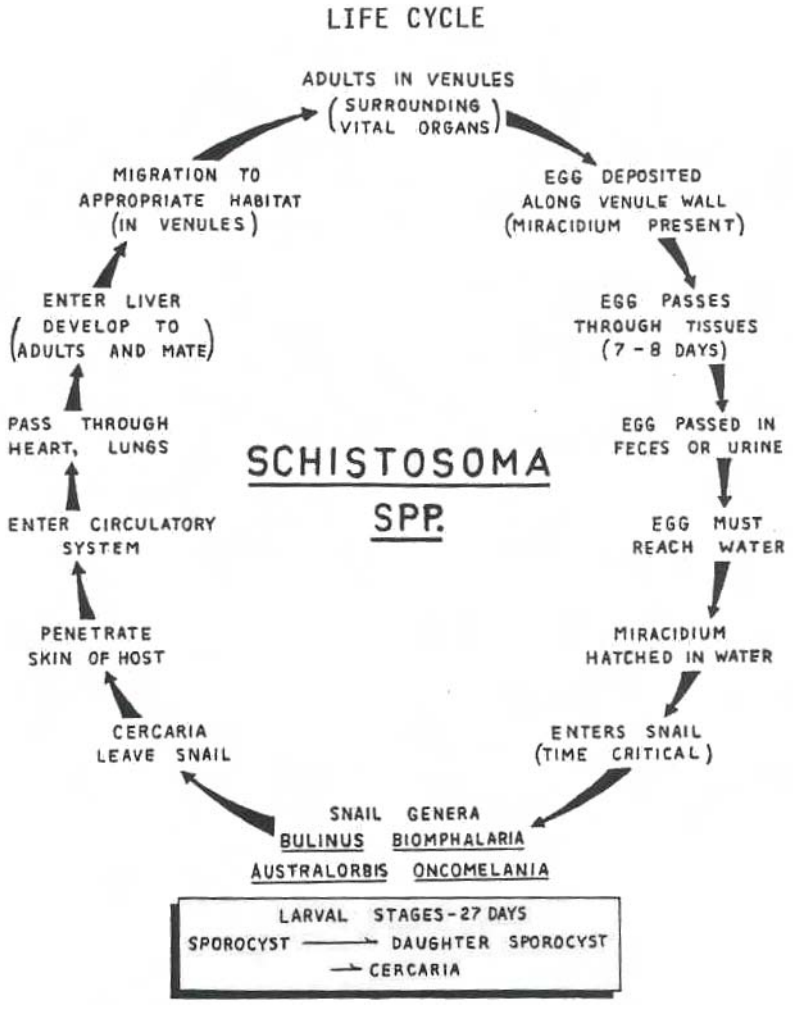

LIFE CYCLE
ADULTS IN VENULES (SURROUNDING VITAL ORGANS)
EGG DEPOSITED ALONG VENULE WALL (MIRACIDIUM PRESENT)
EGG PASSES THROUGH TISSUES (7 - 8 DAYS)
EGG PASSED IN FECES OR URINE
EGG MUST REACH WATER
MIRACIDIUM HATCHED IN WATER
ENTERS SNAIL (TIME CRITICAL)
SNAIL GENERA
BULINUS BIOMPHALARIA
AUSTRALORBIS ONCOMELANIA
CERCARIA LEAVE SNAIL
PENETRATE SKIN OF HOST
ENTER CIRCULATORY SYSTEM
PASS THROUGH HEART, LUNGS
ENTER LIVER (DEVELOP TO ADULTS AND MATE)
MIGRATION TO APPROPRIATE HABITAT (IN VENULES)
SCHISTOSOMA SPP.
LARVAL STAGES - 27 DAYS
SPOROCYST → DAUGHTER SPOROCYST → CERCARIA

Figure 3-14. Life cycle of Schistosoma haemotobium.

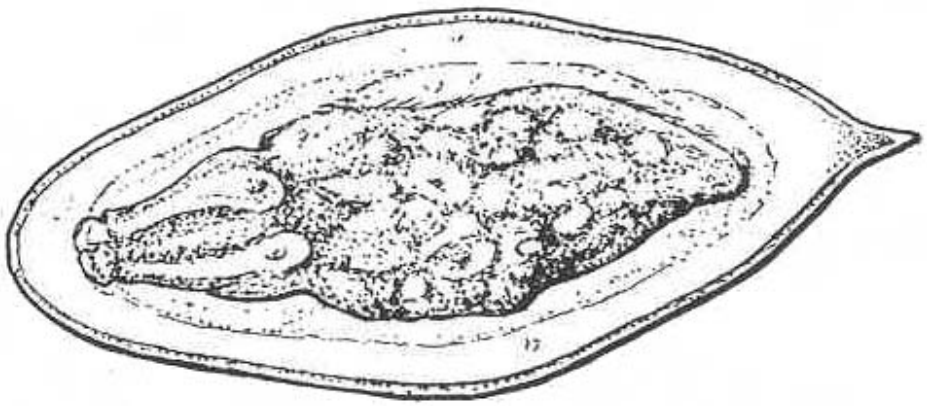
## Schistosoma haemotobium (Continued)

### OVA

SIZE: 145 x 60 mcm (large).

SHAPE: Elongated.

COLOR: Hyaline to light yellow.
OPERCULUM: Absent
CONTENT: Shouldered miracidium surrounded by vitelline membrane (double linear line).
Terminal spine.



### ADULTS

SIZE
MALE: 1.0 to 1.5 cm long x 0.9 mm wide.
FEMALE: 2.0 to 2.5 cm long by 0.25 mm wide.
SHAPE: Elongated with gynecophoral canal in males.
COLOR: Greyish white
INTESTINAL CECA: Join late (near middle of body).
TESTES: Anterior (4 to 5)
OVARIES: In posterior half of body.
UTERUS: Long with 20 to 30 ova.

Figure 3-15. Stages of Schistosoma haemotobium. (continued)

## Schistosoma haemotobium (Continued)

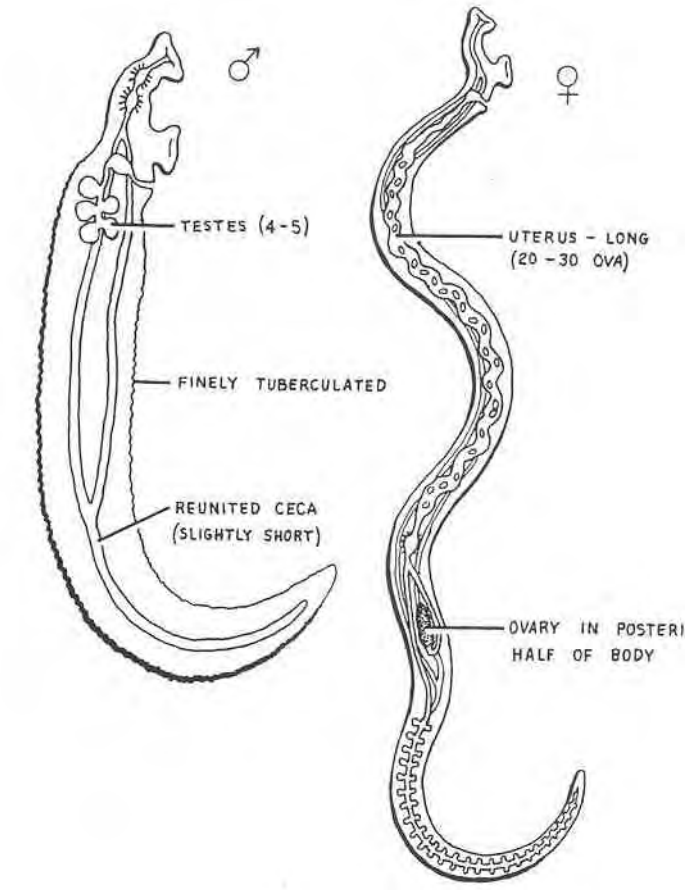



Figure 3-15. Stages of Schistosoma haemotobium. (concluded)

## ORGANISM 4--Paragonimus westermani

### GENERAL CHARACTERISTICS

COMMON NAME: Lung fluke.
GEOGRAPHICAL DISTRIBUTION: Asia and South America
PATHOGENISIS: Pulmonary lesions, fibrous tissue capsules, pleurisy, pneumonitis.
HABITAT: Lung.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Crab or crayfish.
RESERVOIR HOST: Piscivores (fish-eating animals).
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Sputum (also feces).

## Paragonimus westermani (continued)

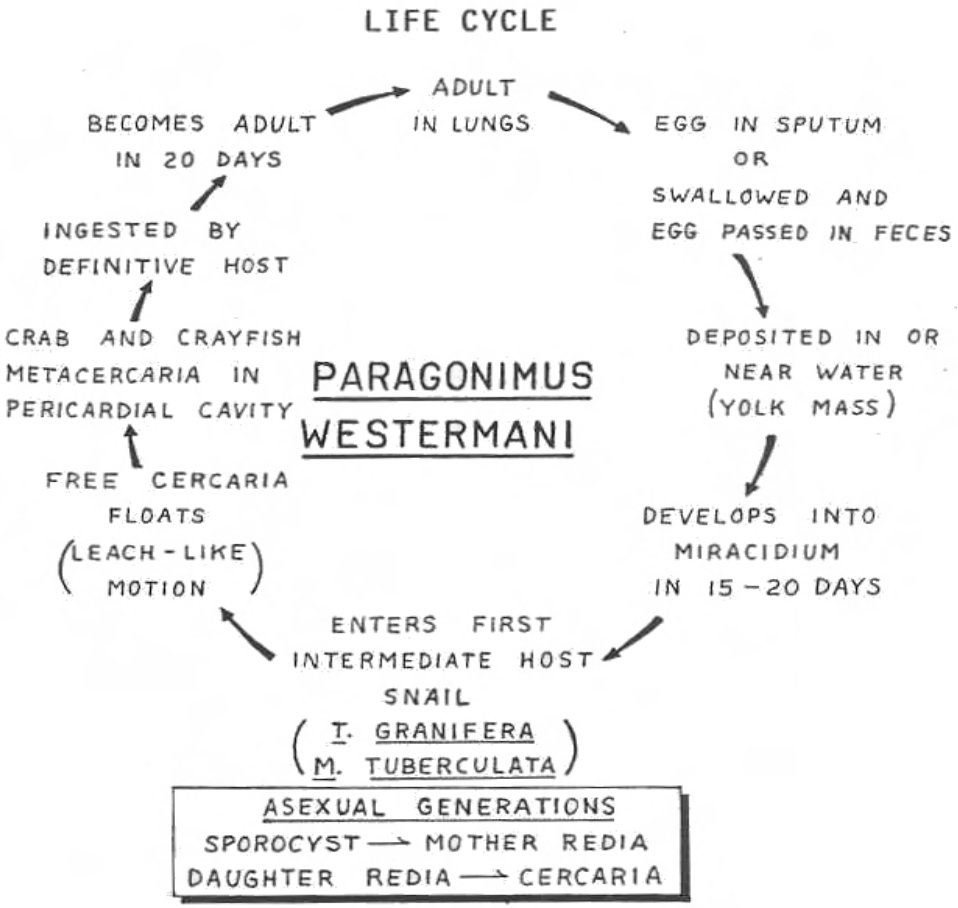
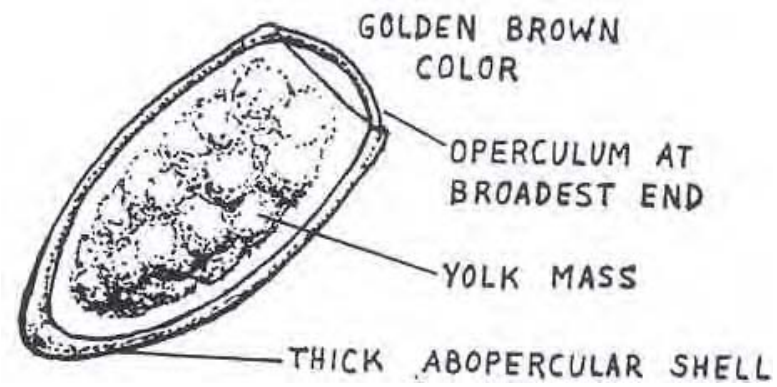

LIFE CYCLE
ADULT IN LUNGS
EGG IN SPUTUM OR SWALLOWED AND EGG PASSED IN FECES
DEPOSITED IN OR NEAR WATER (YOLK MASS)
DEVELOPS INTO MIRACIDIUM IN 15 – 20 DAYS
ENTERS FIRST INTERMEDIATE HOST SNAIL
T. GRANIFERA
M. TUBERCULATA
ASEXUAL GENERATIONS
SPOROCYST → MOTHER REDIA
DAUGHTER REDIA → CERCARIA
FREE CERCARIA FLOATS (LEACH-LIKE MOTION)
CRAB AND CRAYFISH METACERCARIA IN PERICARDIAL CAVITY
INGESTED BY DEFINITIVE HOST
BECOMES ADULT IN 20 DAYS
PARAGONIMUS WESTERMANI

Figure 3-16. Life cycle of Paragonimus westermani.

## Paragonimus westermani (continued)

### OVA

SIZE: 95 x 55 mcm (medium to large; four end-to-end span in HPF).
SHAPE: Oval
COLOR: Golden brown
OPERCULUM: Present at broad end.
CONTENT: Yolk mass "differentiated," variable size of granules in the yolk.
ABOPERCULAR THICKENING




### ADULT

SIZE: 10 to 14 mm long by 3 to 5 mm wide (large).
SHAPE: Oval body.
COLOR: Reddish brown.
INTESTINAL CECA: Undulating.
TESTES: Deeply lobate and para.

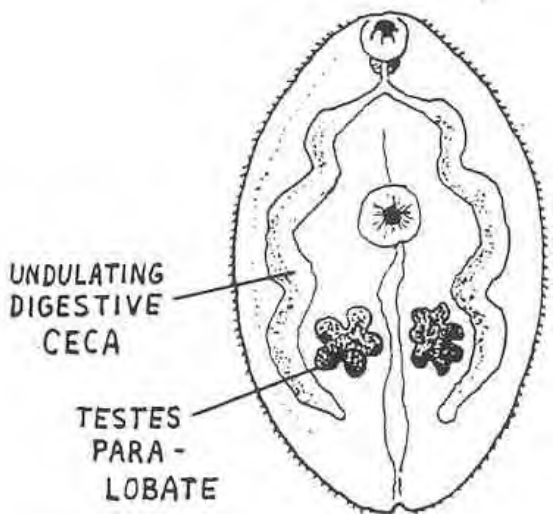



Figure 3-17. Stages of Paragonimus westermani. (concluded)

## ORGANISM 5--Opisthorchis sinensis (Clonorchis sinensis)

### GENERAL CHARACTERISTICS

COMMON NAME: Chinese liver fluke.
GEOGRAPHICAL DISTRIBUTION: Asia
PATHOGENISIS: Mechanical and toxic irritations to liver, destruction of liver parenchyma, jaundice, adenomatous proliferation of tissue cells and liver cirrhosis.
HABITAT: Bile passages.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Fish.
RESERVOIR HOST: Piscivores.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

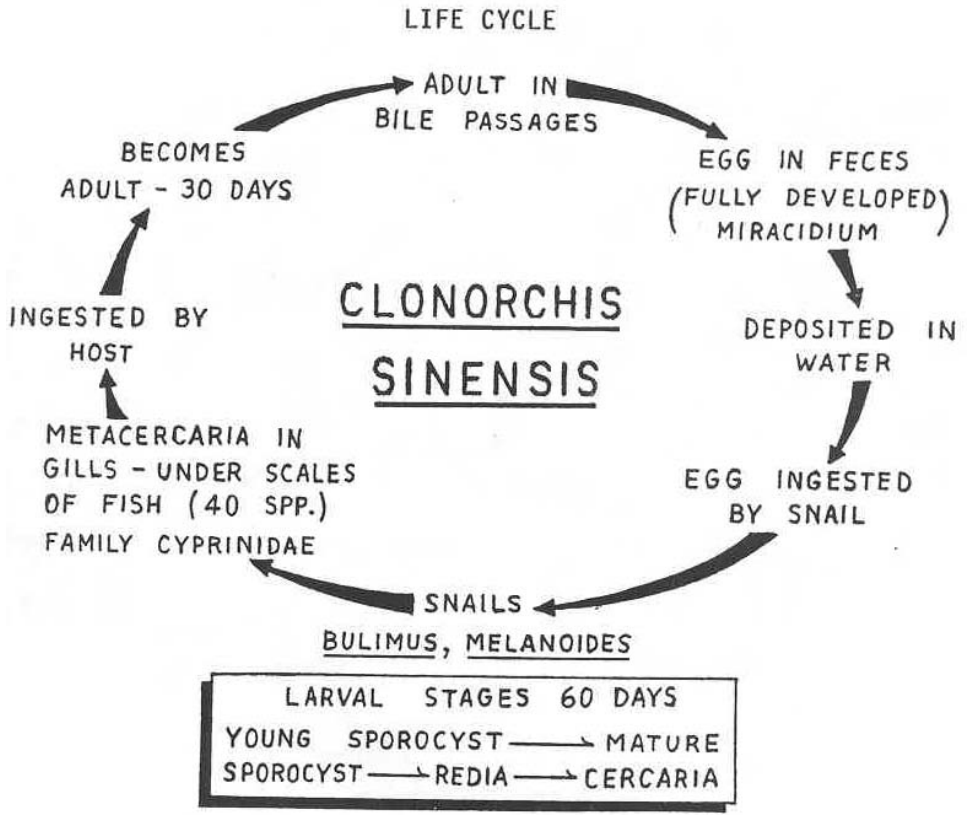

LIFE CYCLE
ADULT IN BILE PASSAGES
EGG IN FECES (FULLY DEVELOPED) MIRACIDIUM
DEPOSITED IN WATER
EGG INGESTED BY SNAIL
SNAILS
BULIMUS, MELANOIDES
LARVAL STAGES 60 DAYS
YOUNG SPOROCYST → MATURE SPOROCYST → REDIA → CERCARIA
METACERCARIA IN GILLS - UNDER SCALES OF FISH (40 SPP.) FAMILY CYPRINIDAE
INGESTED BY HOST
BECOMES ADULT - 30 DAYS
CLONORCHIS SINENSIS

Figure 3-18. Life cycle of Opisthorchis sinensis.

## Opisthorchis sinensis (Clonorchis sinensis) (continued)

### OVA

SIZE: 30 x 15 mcm (small, 12 end to end per HPF).
SHAPE: Vaselike.
COLOR: Yellowish-brown.
OPERCULUM: Present, pronounced.
CONTENT: Asymmetrical miracidium, "boxer's glove" appearance.
ABOPERCULAR COMMA: May be seen.
BROAD OPERCULAR SHOULDERS

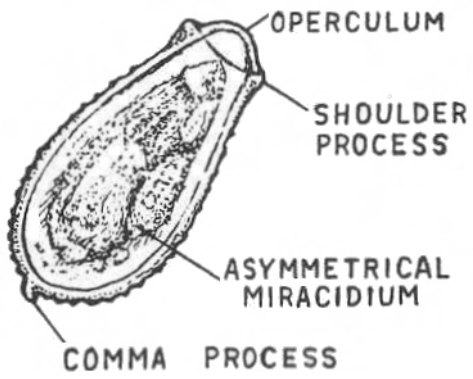



Figure 3-19. Stages of Opisthorchis sinensis. (continued)

### ADULT

SIZE: 10 to 20 mm long by 2 to 5 mm wide (medium).
SHAPE: Oval, elongated.
COLOR: Golden brown to pinkish.
INTESTINAL CECA: Straight.
TESTES: Dendritic and tandem.

## Opisthorchis sinensis (Clonorchis sinensis) (continued)

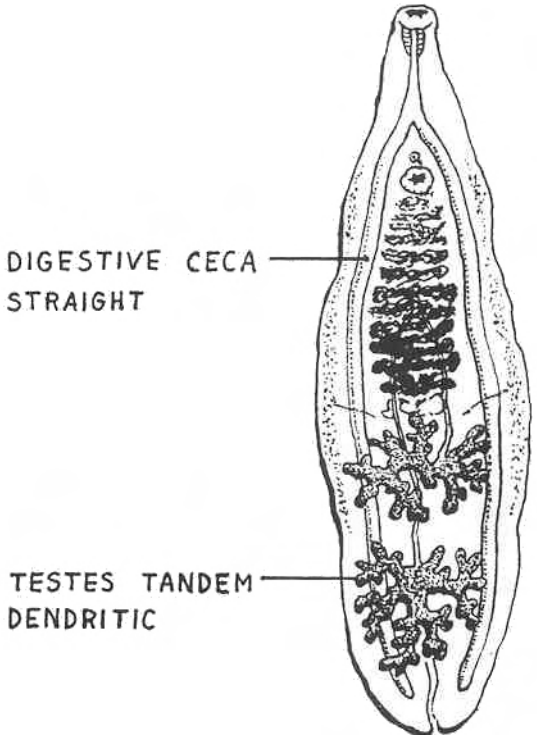



Figure 3-19. Stages of Opisthorchis sinensis. (concluded)

## ORGANISM 6--Opisthorchis species--O. viverrini and O. felineus

### GENERAL CHARACTERISTICS

COMMON NAME: Cat liver fluke.
GEOGRAPHICAL DISTRIBUTION: O. viverrini, Thailand and Laos--O. felineus, Europe, Russia, and Vietnam.
PATHOGENESIS: Mechanical obstruction and toxic irritations in biliary passages, jaundice.
HABITAT: Bile passages.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Fish.



RESERVOIR HOST: Piscivores.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

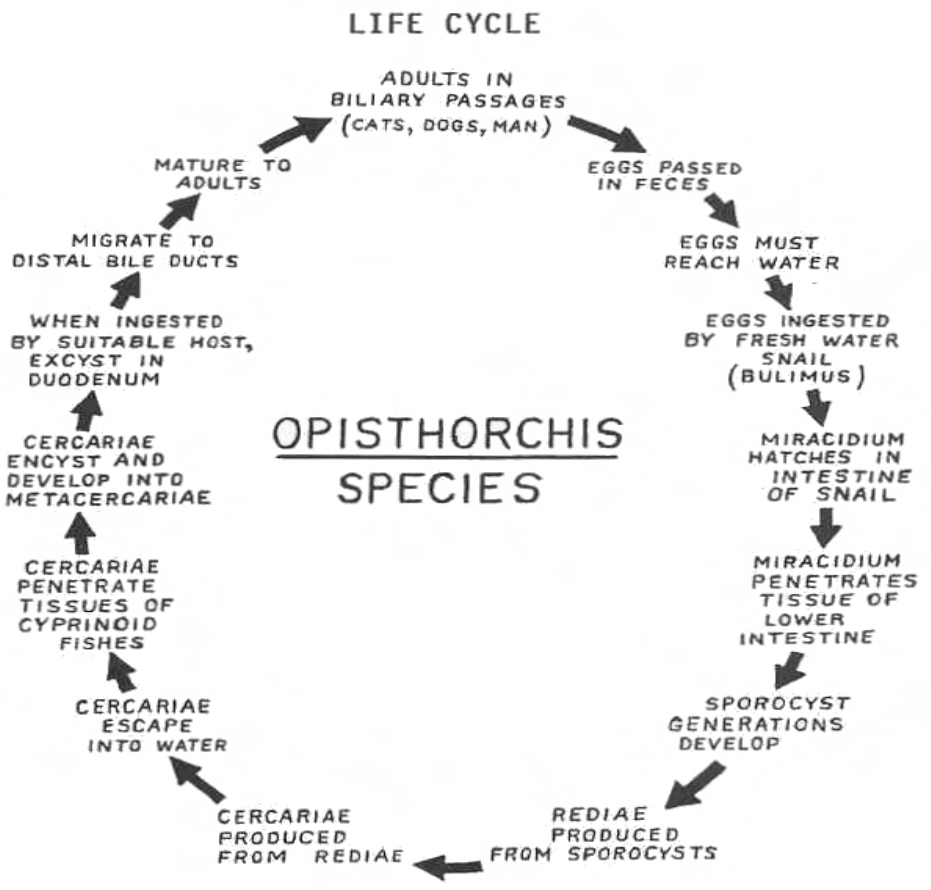
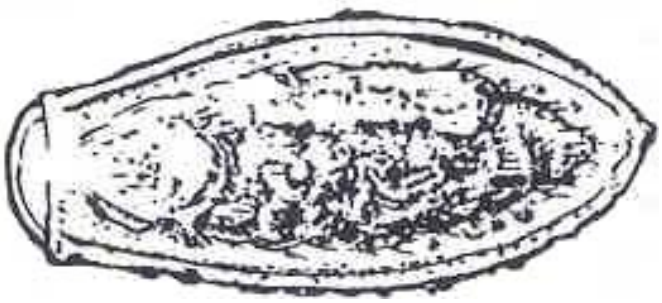

LIFE CYCLE
ADULTS IN BILIARY PASSAGES (CATS, DOGS, MAN)
EGGS PASSED IN FECES
EGGS MUST REACH WATER
EGGS INGESTED BY FRESH WATER SNAIL (BULIMUS)
MIRACIDIUM HATCHES IN INTESTINE OF SNAIL
MIRACIDIUM PENETRATES TISSUE OF LOWER INTESTINE
SPOROCYST GENERATIONS DEVELOP
REDIAE PRODUCED FROM SPOROCYSTS
CERCARIAE PRODUCED FROM REDIAE
CERCARIAE ESCAPE INTO WATER
CERCARIAE PENETRATE TISSUES OF CYPRINOID FISHES
CERCARIAE ENCYST AND DEVELOP INTO METACERCARIAE
WHEN INGESTED BY SUITABLE HOST, EXCYST IN DUODENUM
MIGRATE TO DISTAL BILE DUCTS
MATURE TO ADULTS
OPISTHORCHIS SPECIES

Figure 3-20. Life cycle of Opisthorchis species.

## Opisthorchis species--O. viverrini and O. felineus (continued)

### OVA

SIZE: 30 x 15 mcm (small) (12 end to end per HPF).
SHAPE: Vaselike.
COLOR: Yellowish-brown.
OPERCULUM: Present, pronounced.
CONTENT: Miracidium.



### ADULT

SIZE: 7 to 11 mm long x 2 to 3 mm wide (medium).
SHAPE: Oval, elongated
COLOR: Grey to brown
INTESTINAL CECA: Straight
TESTES: Lobed and oblique

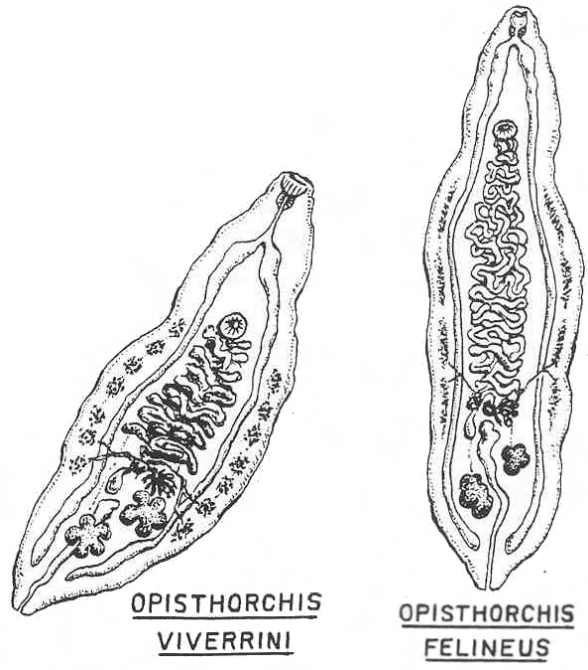



Figure 3-21. Stages of Opisthorchis species.

## ORGANISM 7--Dicrocoelium dendriticum

### GENERAL CHARACTERISTICS

COMMON NAME: Lancet fluke.
GEOGRAPHICAL DISTRIBUTION: Cosmopolitan.
PATHOGENESIS: Inflammation of biliary epithelium, biliary dysfunction, edema, toxemia.
HABITAT: Liver
INTERMEDIATE HOST
FIRST: Land snail.
SECOND: Black ant (Formica fusca).
RESERVOIR HOST: Herbivores.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

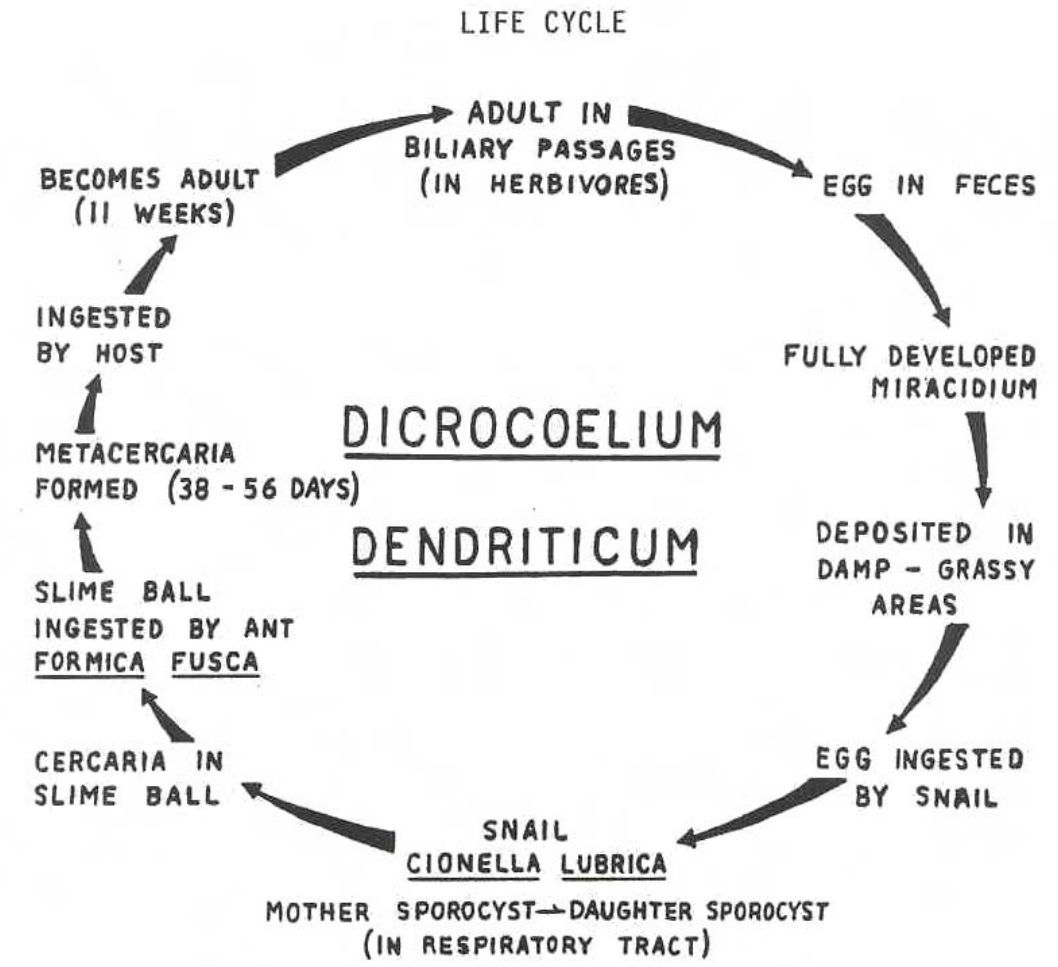
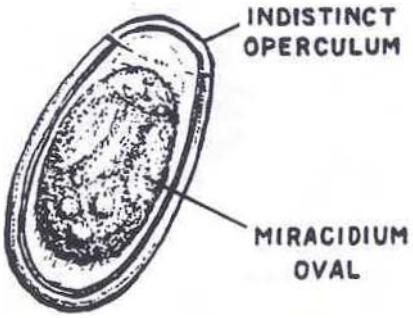

LIFE CYCLE
ADULT IN BILIARY PASSAGES (IN HERBIVORES)
EGG IN FECES
FULLY DEVELOPED MIRACIDIUM
DEPOSITED IN DAMP - GRASSY AREAS
EGG INGESTED BY SNAIL
SNAIL CIONELLA LUBRICA
MOTHER SPOROCYST→DAUGHTER SPOROCYST (IN RESPIRATORY TRACT)
CERCARIA IN SLIME BALL
SLIME BALL INGESTED BY ANT FORMICA FUSCA
METACERCARIA FORMED (38 - 56 DAYS)
INGESTED BY HOST
BECOMES ADULT (11 WEEKS)
DICROCOELIUM DENDRITICUM

Figure 3-22. Life cycle of Dicrocoelium dendriticum.

## Dicrocoelium dendriticum (Continued)

### OVA

SIZE: 40 x 25 mcm.
SHAPE: Oval (race track).
COLOR: Light brown.
OPERCULUM: Present, indistinct.
CONTENT: Miracidium.




### ADULT

SIZE: 5 to 12 mm long by 1.5 to 2.5 mm wide (medium).
SHAPE: Elongated, lancet.
COLOR: Transparent.
INTESTINAL CECA: Straight.
TESTES: Shallow lobed and oblique; found in anterior half of the body.

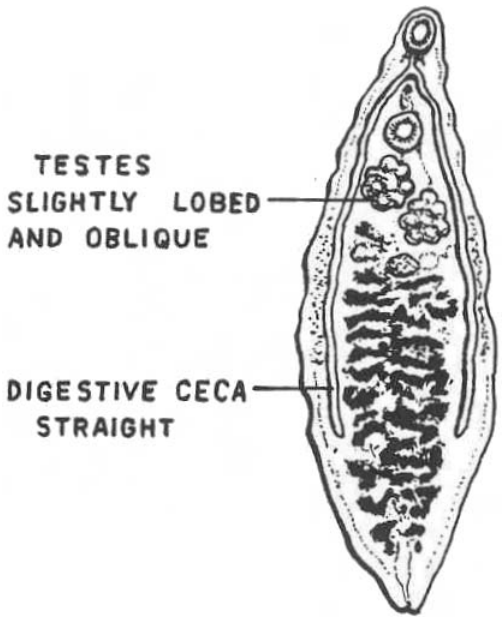



Figure 3-23. Stages of Dicrocoelium dendriticum.

## ORGANISM 8--Fasciola hepatica

### GENERAL CHARACTERISTICS

COMMON NAME: Sheep liver fluke.
GEOGRAPHICAL DISTRIBUTION: Worldwide; sheep-raising countries.
PATHOGENESIS: Mechanical and toxic irritation to liver, destruction of hepatic parenchyma, biliary obstruction, adenomatous and fibrotic changes, anemia (0.2 ccblood loss per worm per day), eosinophilia, cirrhosis (periportal).
HABITAT: Bile passages.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Fresh water vegetation (watercress).
RESERVOIR HOST: Herbivores and carnivores.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion
SPECIMEN OF CHOICE: Feces.

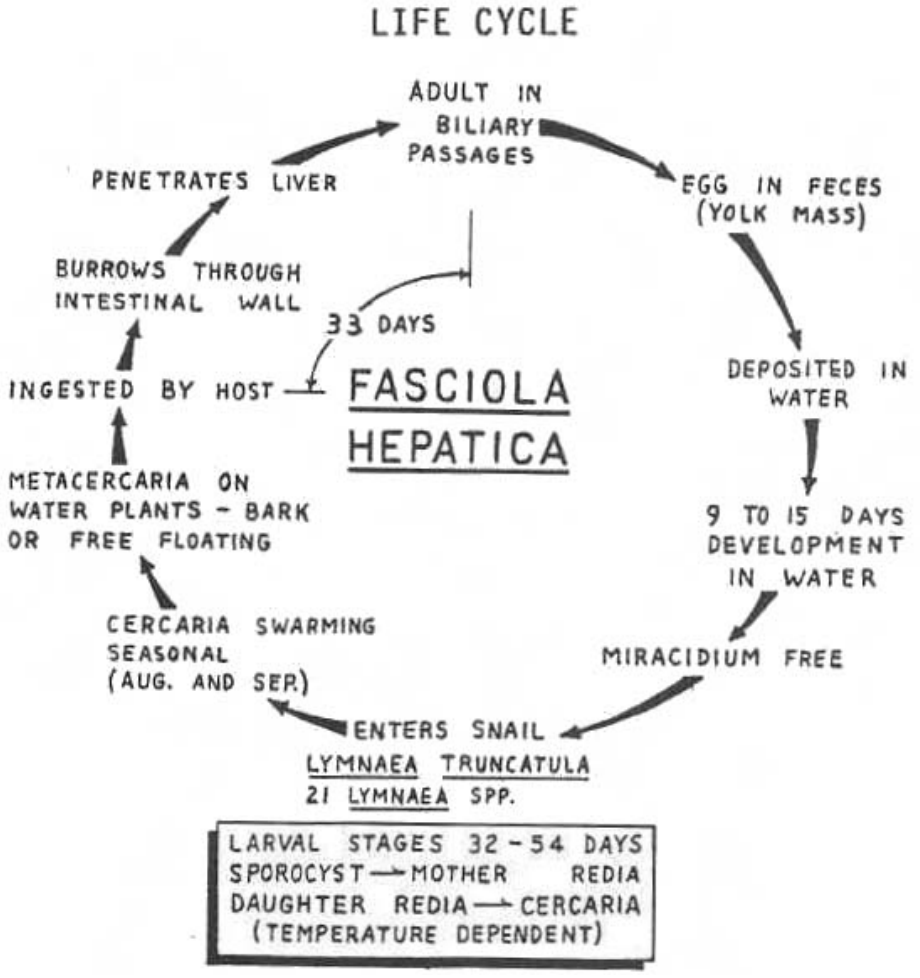
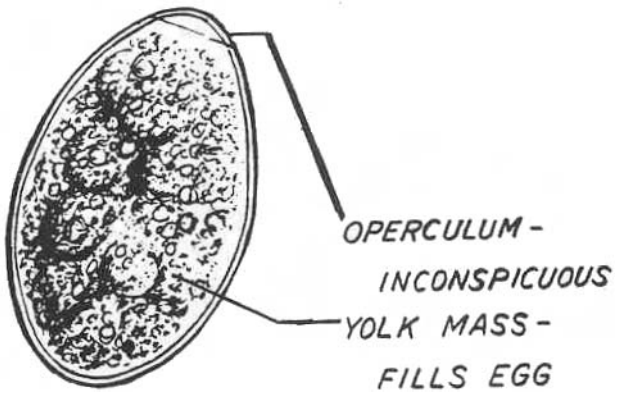



Figure 3-24. Life cycle of Fasciola hepatica.

## Fasciola hepatica (continued)

### OVA

SIZE: 140 x 80 mcm (large, 3 end to end will fill HPF).
SHAPE: "Hen's egg"; oval.
COLOR: Yellowish-brown
OPERCULUM: Present, indistinct.
CONTENT: Yolk mass; fills the egg.




### ADULT

SIZE: 20 to 30 mm long by 8 to 13 mm wide (very large).
SHAPE: Leaf-like; prominent cephalic cone.
COLOR: Brownish.
INTESTINAL CECA: Branched.
TESTES: Dendritic and tandem.

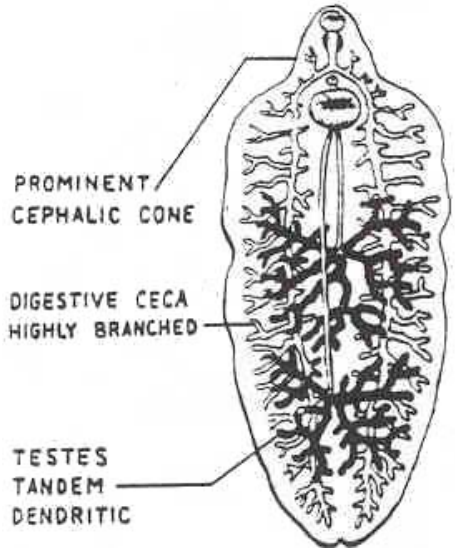



Figure 3-25. Stages of Fasciola hepatica.

## ORGANISM 9--Fasciolopsis buski

### GENERAL CHARACTERISTICS

COMMON NAME: Giant intestinal fluke.
GEOGRAPHICAL DISTRIBUTION: Asia.
PATHOGENESIS: Intestinal inflammation, ulceration and abcesses; generalized massive edema, obstruction, eosinophilia up to 35.
HABITAT: Small intestines.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Aquatic vegetation.
RESERVOIR HOST: Pigs, dogs, and rabbits.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

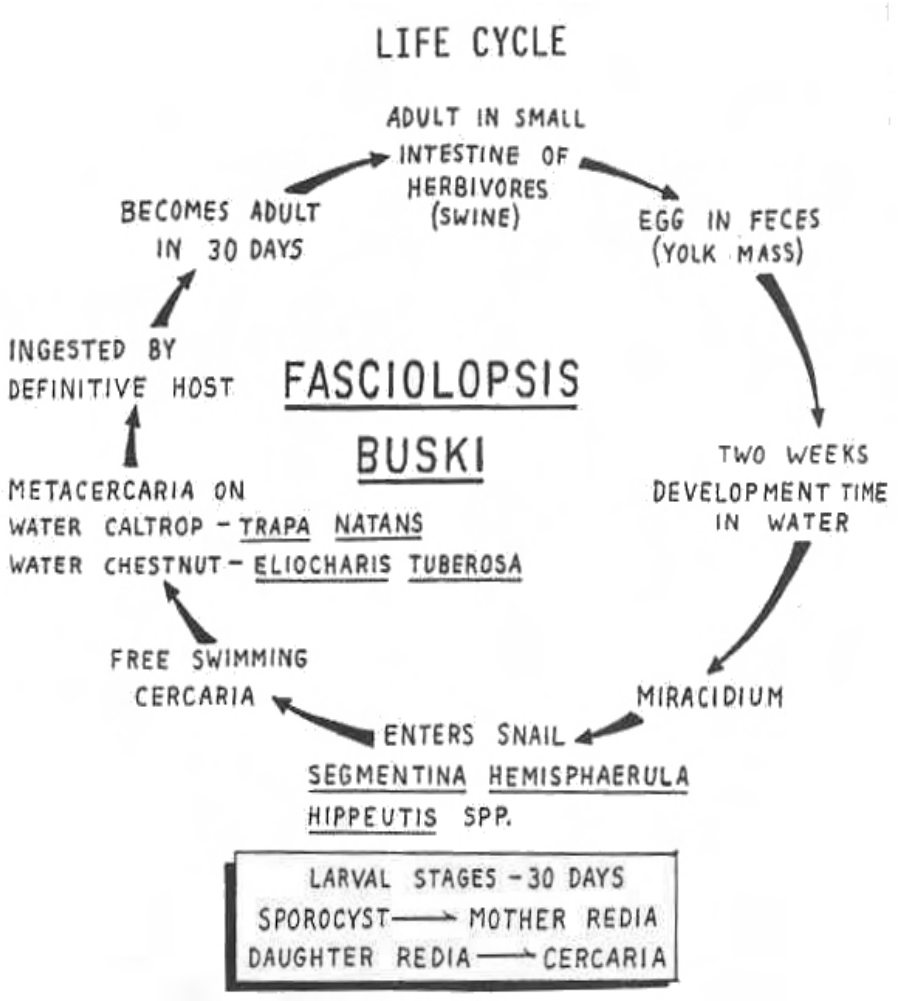
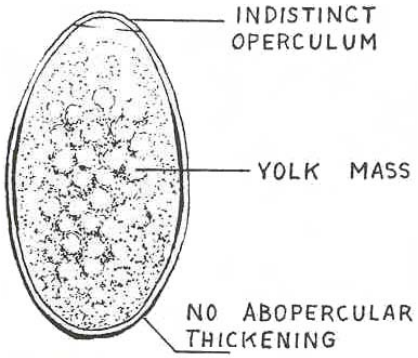



Figure 3-26. Life cycle of Fasciolopsis buski.

## Fasciolopsis buski (continued)

### OVA

Almost identical to F. hepatica except that the granules in the yolk mass are uniformly distributed.
SIZE: 140 x 80 mcm (large, 3 end to end will fill HPF).
SHAPE: "Hen's egg"; oval.
COLOR: Yellowish-brown.
OPERCULUM: Present, indistinct.
CONTENT: Yolk mass; fills the egg.




### ADULT

SIZE: 25 to 45 mm long by 8 to 12 mm wide (very large).
SHAPE: Leaf-like, no cephalic cone.
COLOR: Flesh-colored.
INTESTINAL CECA: Undulating.
TESTES: Dendritic and tandem.

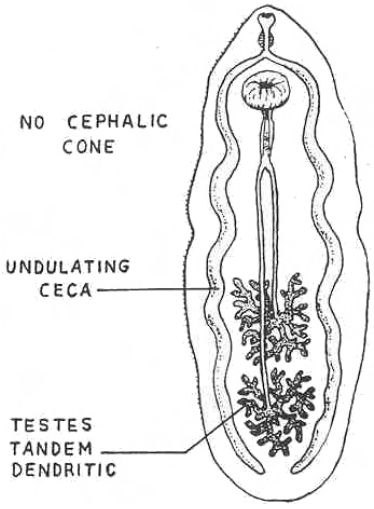



Figure 3-27. Stages of Fasciolopsis buski.

## ORGANISM 10--Metagonimus yokogawai

### GENERAL CHARACTERISTICS

COMMON NAME: Small intestinal fluke.
GEOGRAPHICAL DISTRIBUTION: Far East
PATHOGENESIS: Occasionally eggs may enter lymphatics or mesenteric venules causing granulomatous lesions in heart and nervous system.
HABITAT: Small intestines.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Fish.
RESERVOIR HOST: Piscivores and birds.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

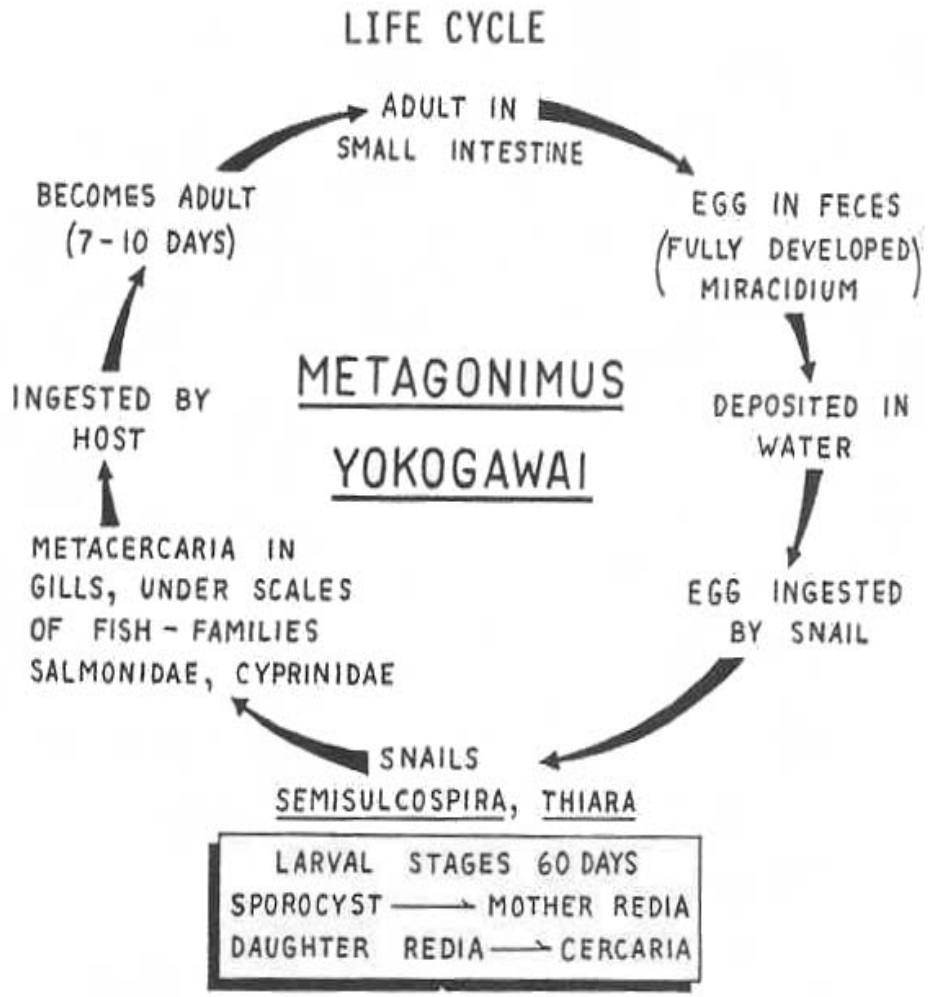
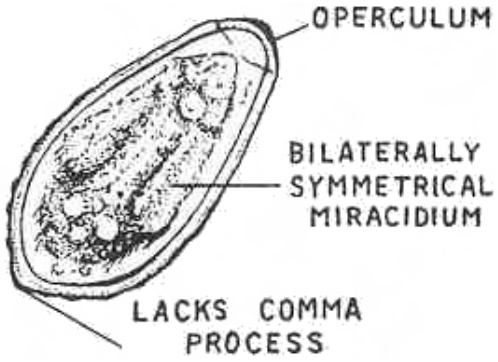

LIFE CYCLE
ADULT IN SMALL INTESTINE
EGG IN FECES (FULLY DEVELOPED MIRACIDIUM
DEPOSITED IN WATER
EGG INGESTED BY SNAIL
SNAILS SEMISULCOSPIRA, THIARA
LARVAL STAGES 60 DAYS
SPOROCYST → MOTHER REDIA
DAUGHTER REDIA → CERCARIA
METACERCARIA IN GILLS, UNDER SCALES OF FISH - FAMILIES SALMONIDAE, CYPRINIDAE
INGESTED BY HOST
BECOMES ADULT (7-10 DAYS)
METAGONIMUS YOKOGAWAI

Figure 3-28. Life cycle of Metagonimus yokogawai.

## Metagonimus yokogawai (continued)

### OVA

SIZE: 30 x 15 mcm (small, 12 end to end per HPF), resemble ova of the Opisthorchis sp.
SHAPE: Vaselike.
COLOR: Yellowish-brown.
OPERCULUM: Present, pronounced.
CONTENT: Miracidium (symmetrical).




### ADULT

SIZE: 0.8 to 1.4 mm long by 0.4 to 0.7 mm wide.
SHAPE: Gourd-like
COLOR: Grayish
INTESTINAL CECA: Straight
TESTES: Oval and oblique
OFF-CENTER ACETABULUM

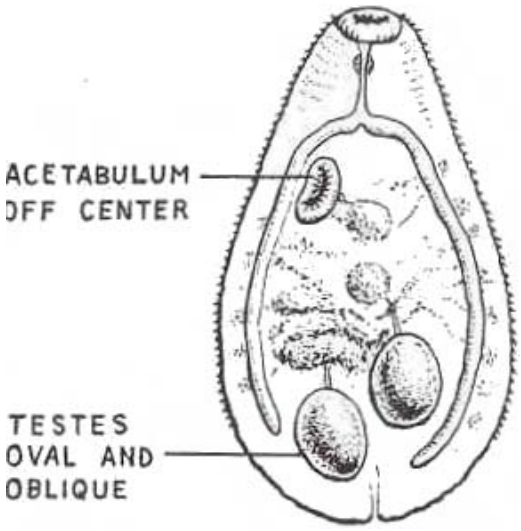



Figure 3-29. Stages of Metagonimus yokagawai.

## ORGANISM 11--Heterophyes heterophyes

### GENERAL CHARACTERISTICS

COMMON NAME: Small intestinal fluke.
GEOGRAPHICAL DISTRIBUTION: Egypt, (same as M. yokogawai) Palestine, Far East.
HABITAT: Small intestines.
INTERMEDIATE HOST
FIRST: Snail.
SECOND: Fish.
RESERVOIR HOST: Piscivores and birds.
INFECTIVE FORM: Metacercaria.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

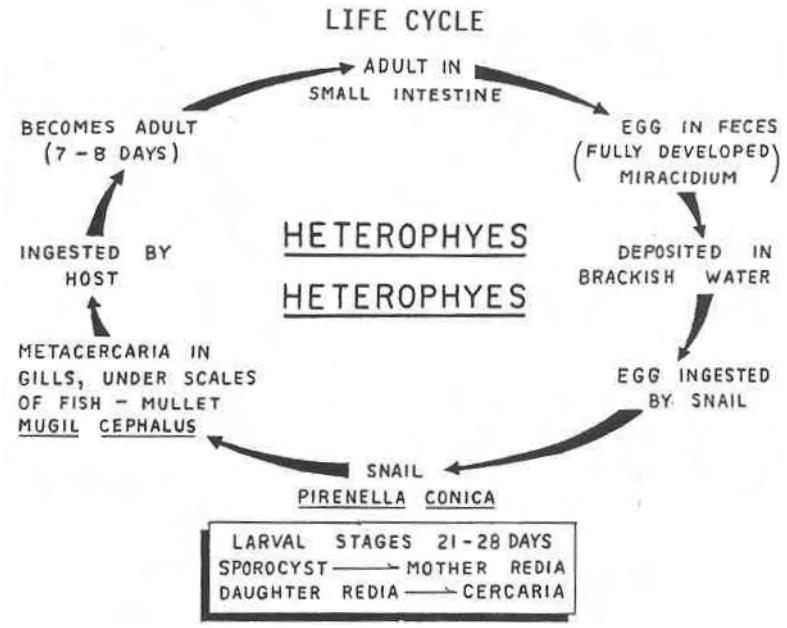
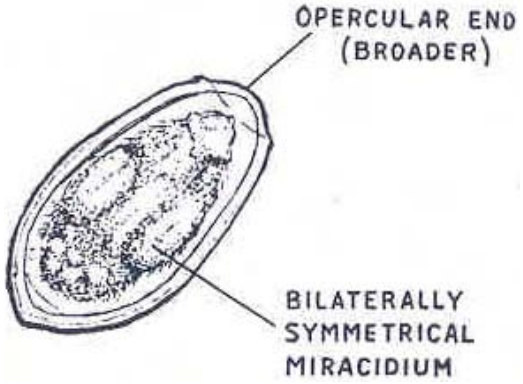

LIFE CYCLE
ADULT IN SMALL INTESTINE
EGG IN FECES (FULLY DEVELOPED MIRACIDIUM)
DEPOSITED IN BRACKISH WATER
EGG INGESTED BY SNAIL
SNAIL PIRENELLA CONICA
METACERCARIA IN GILLS, UNDER SCALES OF FISH - MULLET MUGIL CEPHALUS
INGESTED BY HOST
BECOMES ADULT (7 - 8 DAYS)
HETEROPHYES
HETEROPHYES
LARVAL STAGES 21 - 28 DAYS
SPOROCYST → MOTHER REDIA
DAUGHTER REDIA → CERCARIA

Figure 3-30. Life cycle of Heterophyes heterophyes.

## Heterophyes heterophyes (continued)

### OVA

SIZE: 30 x 15 mcm (small, 12 end to end per HPF), resemble ova of the Opisthorchis sp.
SHAPE: Vaselike.
COLOR: Yellowish-brown.
OPERCULUM: Present, pronounced.
CONTENT: Miracidium.




### ADULT

SIZE: 1.0 to 1.7 mm long by 0.3 to 0.7 mm wide (very small).
SHAPE: Gourd-like.
COLOR: Grayish.
INTESTINAL CECA: Straight.
CENTERED ACETABULUM
GONOTYL IS PRESENT
Retractile sucker-like structure.
Armed with hooklets.

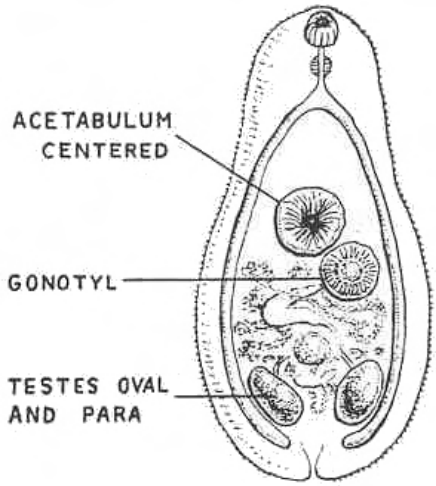



Figure 3-31. Stages of Heterophyes heterophyes.

## ORGANISM 12--Gastrodiscoides hominis

### GENERAL CHARACTERISTIC

COMMON NAME: Colonic fluke.
GEOGRAPHICAL DISTRIBUTION--India, Viet Nam.
PATHOGENESIS: Mucosal inflammation of cecum and ascending colon.
HABITAT: large intestines; cecum and colon.
INTERMEDIATE HOST
FIRST--Snail.
SECOND--Aquatic vegetation.
RESERVOIR HOST--Hogs and Napu mouse deers.
INFECTIVE FORM--Metacercaria.
MODE OF INFECTION--Ingestion.
SPECIMEN OF CHOICE--Feces.

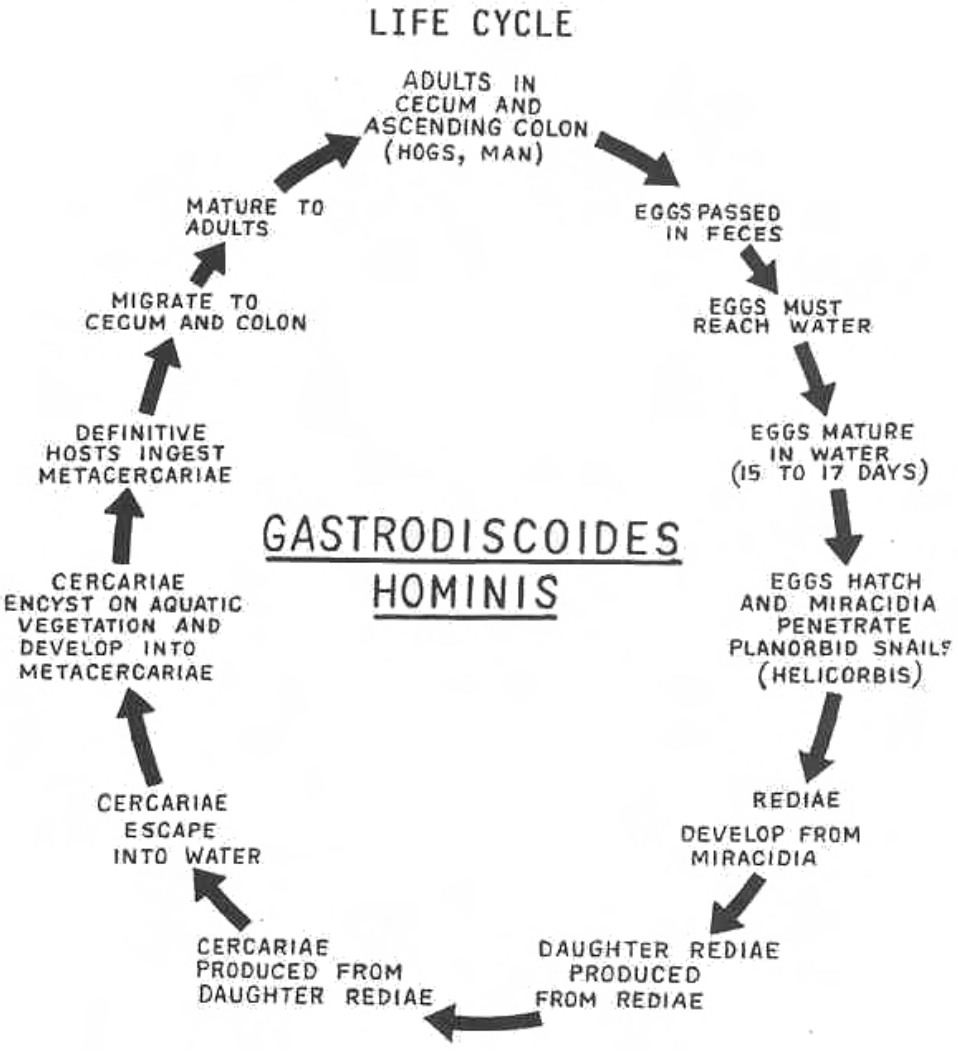
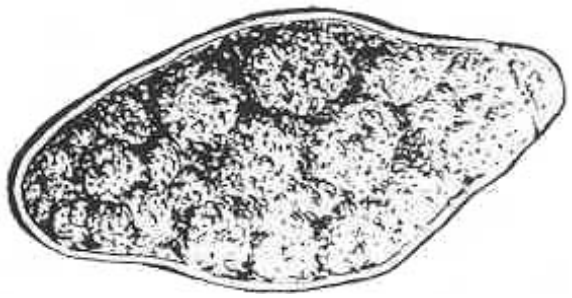

LIFE CYCLE
ADULTS IN CECUM AND ASCENDING COLON (HOGS, MAN)
EGGS PASSED IN FECES
EGGS MUST REACH WATER
EGGS MATURE IN WATER (15 TO 17 DAYS)
EGGS HATCH AND MIRACIDIA PENETRATE PLANORBID SNAILS (HELICORBIS)
REDIAE DEVELOP FROM MIRACIDIA
DAUGHTER REDIAE PRODUCED FROM REDIAE
CERCARIAE PRODUCED FROM DAUGHTER REDIAE
CERCARIAE ESCAPE INTO WATER
CERCARIAE ENCYST ON AQUATIC VEGETATION AND DEVELOP INTO METACERCARIAE
DEFINITIVE HOSTS INGEST METACERCARIAE
MIGRATE TO CECUM AND COLON
MATURE TO ADULTS
GASTRODISCOIDES HOMINIS

Figure 3-32. Life cycle of Gastrodiscoides hominis.

## Gastrodiscoides hominis (continued)

### OVA

SIZE--160 x 65 mcm (large).
SHAPE--Spindle-shaped.
COLOR--Light brown.
OPERCULUM--Present, distinct.
CONTENT--Yolk mass.



### ADULT

SIZE--5 to 10 mm long by 2 to 5 mm wide (medium).
SHAPE--Gourd-like
COLOR--Reddish
INTESTINAL CECA--Straight
TESTES--Anterior, lobate, and tandem.
ACETABULUM--Very wide and posterior.

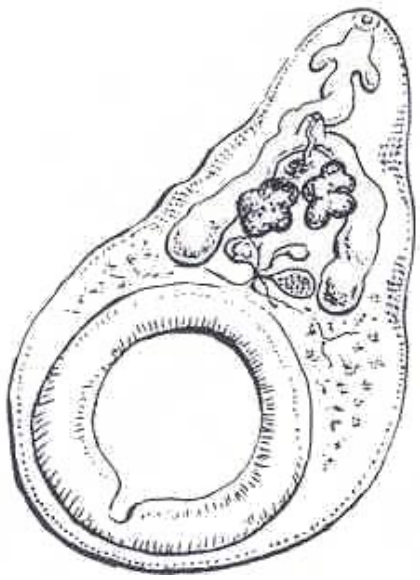


Figure 3-33. Stages of Gastrodiscoides hominis.

## ORGANISM 13--Echinostoma species

### GENERAL CHARACTERISTICS

COMMON NAME--Spiny fluke.
GEOGRAPHICAL DISTRIBUTION: Asia.
PATHOGENESIS--Heavy infections induce catarrhal inflammations; necrosis of mucosa.
HABITAT--Small intestines.
INTERMEDIATE HOST
FIRST--Snail.
SECOND--Clam or snail.
RESERVOIR HOST--Dogs, cats, rats, and birds.
INFECTIVE FORM--Metacercaria.
MODE OF INFECTION--Ingestion.
SPECIMEN OF CHOICE--Feces.

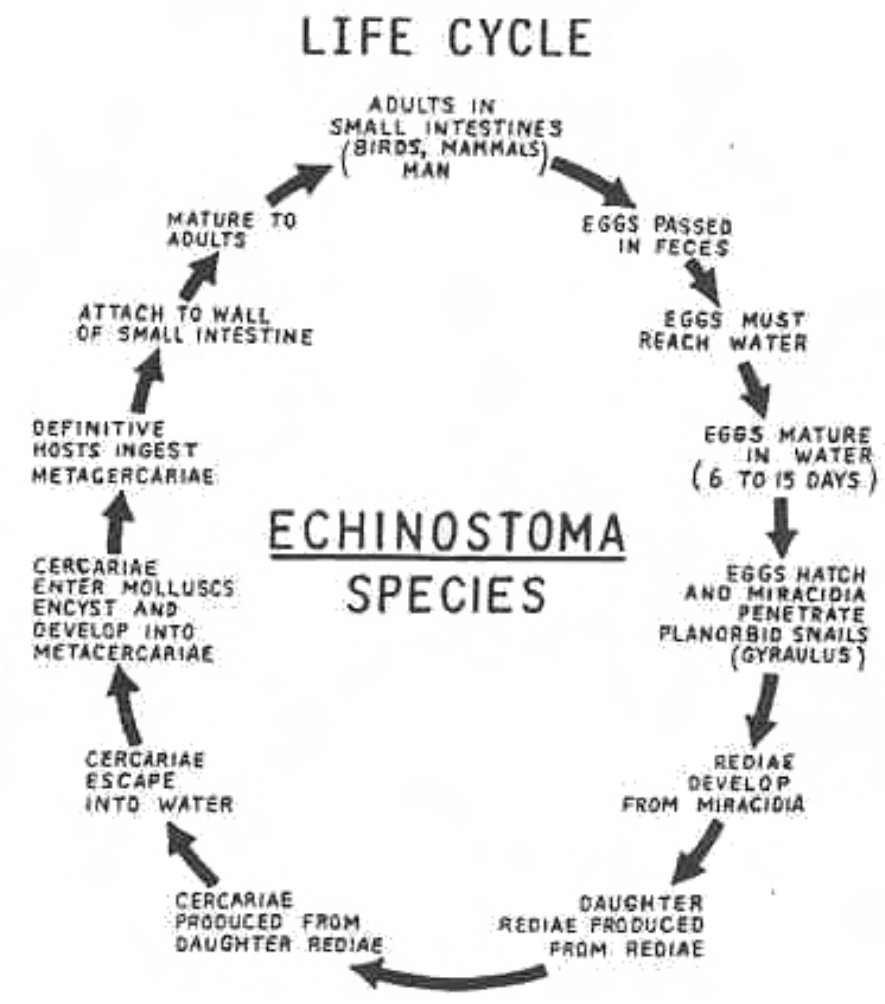
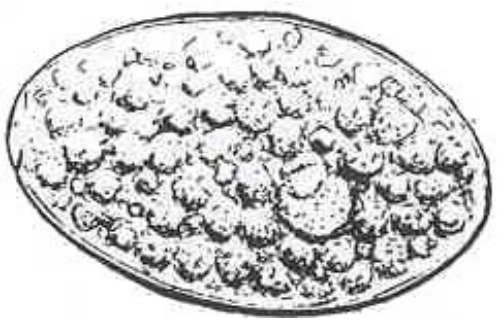

LIFE CYCLE
ADULTS IN SMALL INTESTINES (BIRDS, MAMMALS) MAN
EGGS PASSED IN FECES
EGGS MUST REACH WATER
EGGS MATURE IN WATER (6 TO 15 DAYS)
EGGS HATCH AND MIRACIDIA PENETRATE PLANORBID SNAILS (GYRAULUS)
REDIAE DEVELOP FROM MIRACIDIA
DAUGHTER REDIAE PRODUCED FROM REDIAE
CERCARIAE PRODUCED FROM DAUGHTER REDIAE
CERCARIAE ESCAPE INTO WATER
CERCARIAE ENTER MOLLUSCS ENCYST AND DEVELOP INTO METACERCARIAE
DEFINITIVE HOSTS INGEST METACERCARIAE
ATTACH TO WALL OF SMALL INTESTINE
MATURE TO ADULTS
ECHINOSTOMA SPECIES

Figure 3-34. Life cycle of Echinostoma species.

## Echinostoma species (continued)

### OVA

SIZE: 90 x 60 mcm (large, smaller than F. hepatica).
SHAPE: Hen's egg, similar to F. hepatica.
COLOR: Straw.
OPERCULUM: Present, indistinct.
CONTENT--Yolk mass.



### ADULT

SIZE: 5 to 20 mm long by 2 to 5 mm wide (medium).
SHAPE: Oval, elongated.
COLOR: Reddish-gray
INTESTINAL CECA: Straight
TESTES: Lobate and tandem.
CIRCUMORAL DISK: Circlet of spines around the oralsucker.

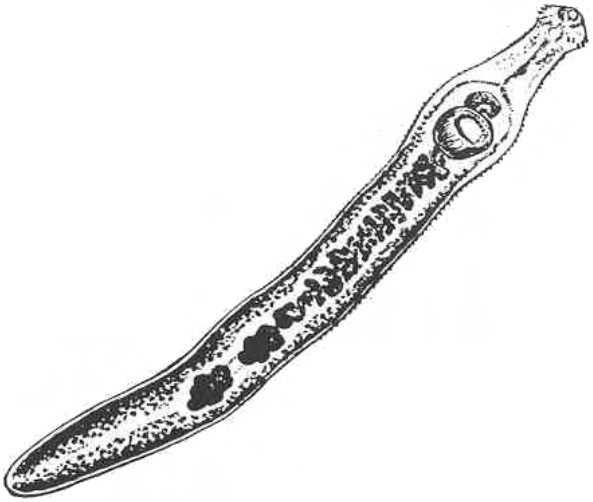


Figure 3-35. Stages of Echinostoma species.

## Section III. CLASS CESTODA

### 3-8. GENERAL COMMENTS

This class consists of polyzoic (many body parts) flat worms commonly known as tapeworms. Evolution has rendered these organisms as strict parasites incapable of a free living condition. The digestive tract is absent and the worms absorb their nutrients from the surroundings. The muscular system is poorly developed. The reproductive system, on the other hand, has been developed to such an extent that over 90reproductive structures. Both male and female organs are found in each individual segment which is called a proglottid. Excretion is handled by a pair of longitudinal excretory canals which run the entire length of the proglottid. Longitudinal nerve cords are also found to be shared by the complete worm. Reproduction is sexual and it is performed internally. Most times, the tapeworms cross-fertilize between two different worms, but fertilization may take place between two individual proglottids of the same organism. They have a complex life cycle requiring, in most instances, at least one intermediate host where the larval stages must develop prior to infecting the definitive host again. Each individual life cycle will be discussed with the corresponding organism.

### 3-9. ORDERS

There are two orders within this class. The order Pseudophyllidea contains Diphyllobothrium latum and Spirometra species. Cyclophyllidea contains members of Taenia, Taeniarhynchus, Echinococcus, Hymenolepsis, and Dipylidium.

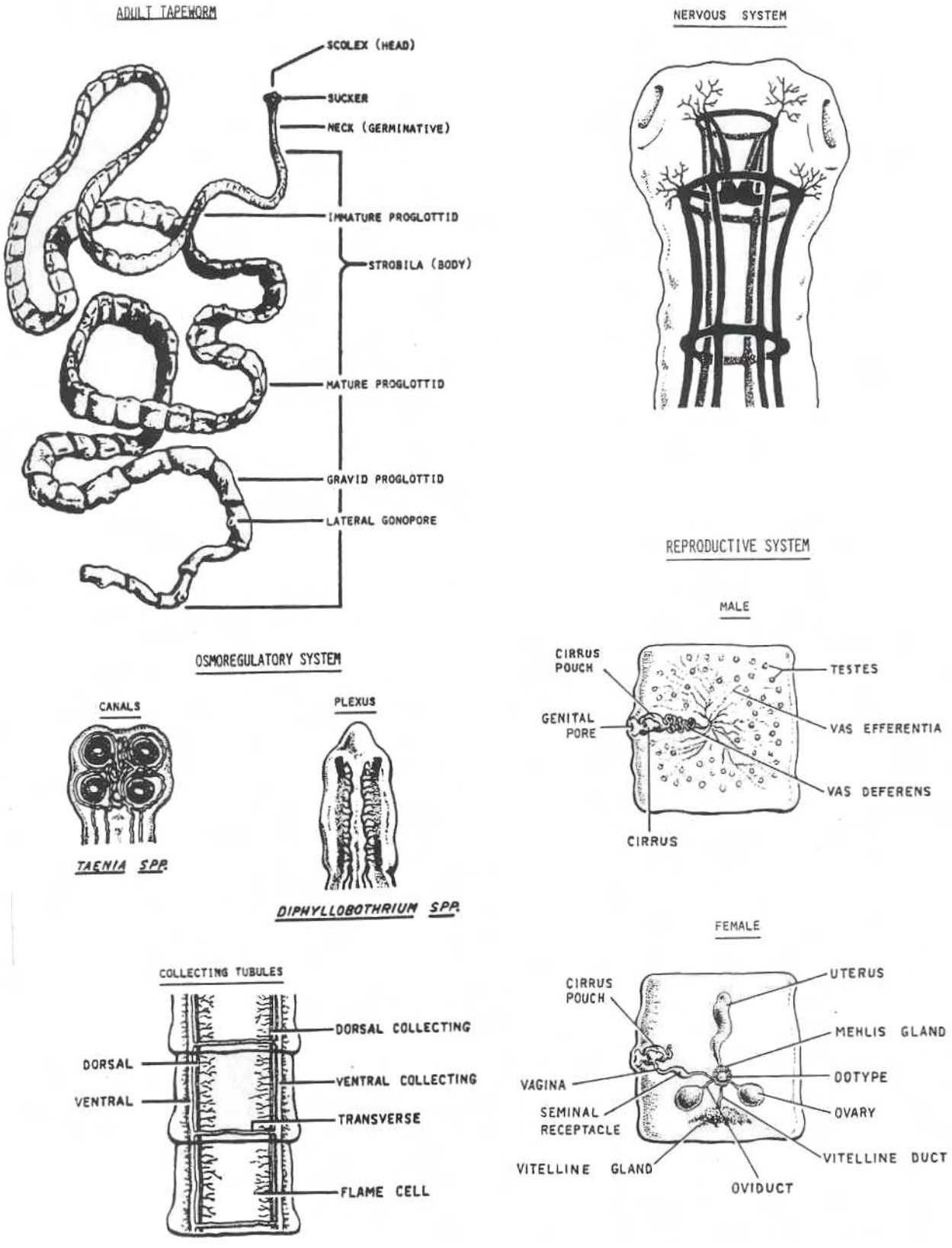



Figure 3-36. Typical tapeworm.

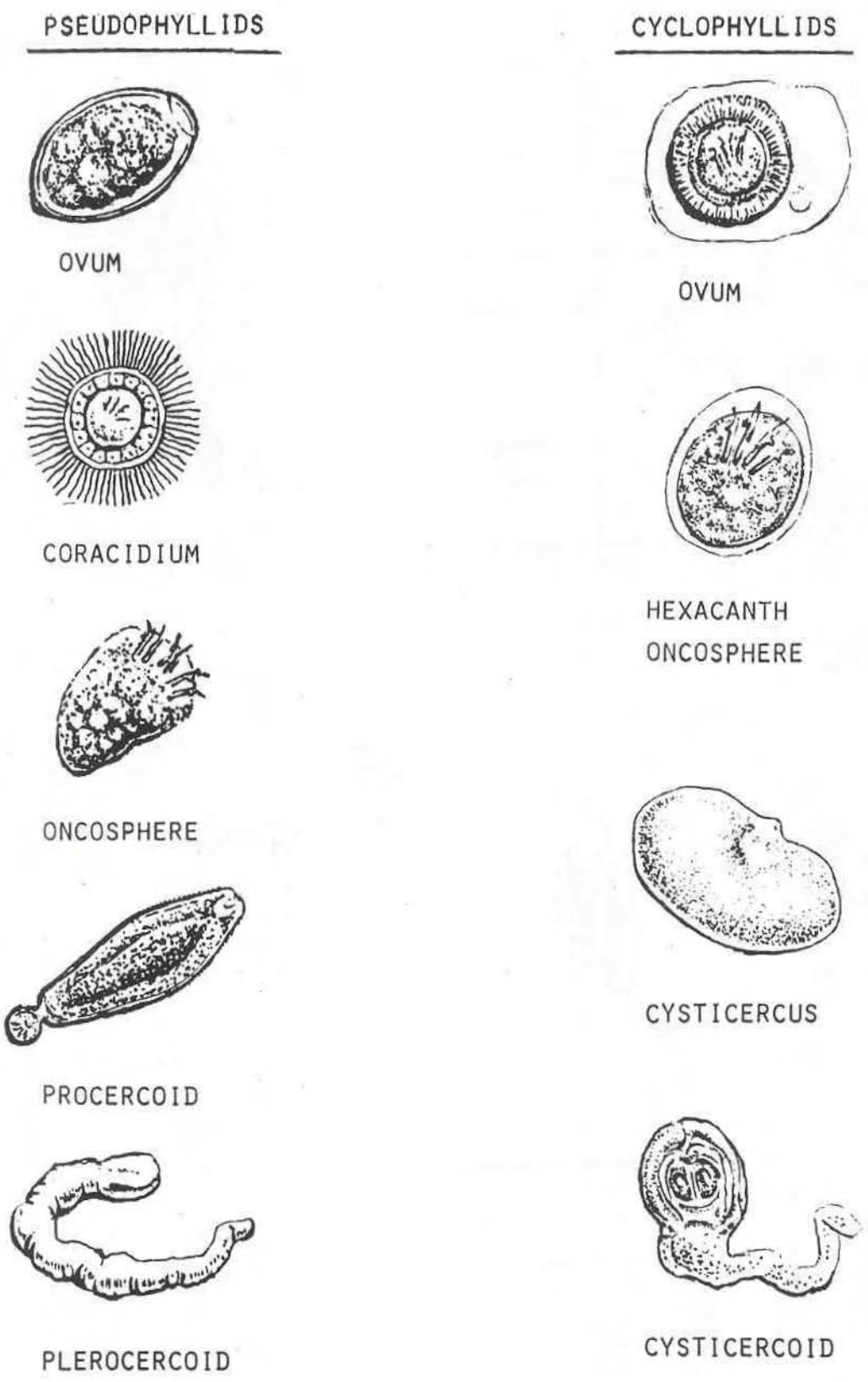



Figure 3-37. Examples of Cestoda ova and larval stages.

**KEY TO IMPORTANT ADULT HUMAN CESTODES**

| | | |
|---|---|---|
| 1. | Scolex "head" recovered | 2 |
| | Gravid proglottids recovered | 5 |
| | Complete worm (scolex & 3 proglottids: immature, mature, and gravid) | *Echinococcus* species |
| 2. | Large scolex (about 1-2 mm) | 3 |
| | Small scolex (0.3 to 0.5 mm) | 4 |
| 3. | Scolex with two longitudinal, slit-like grooves or suckers | *Diphyllobothrium latum* |
| | Scolex with four round suckers, unarmed | *Taeniarhynchus saginatus* |
| | Scolex with four round suckers, armed | *Taenia solium* |
| 4. | Scolex club-shaped about 0.5 mm, unarmed | *Hymenolepis diminuta* |
| | Scolex armed with one row of large hooks, about 0.3 mm in diameter | *Hymenolepis nana* |
| | Scolex armed with 3-7 rows of small hooks, 0.25 to 0.5 mm in diameter | *Dipylidium caninum* |
| 5. | Segments broader than long | 6 |
| | Segments longer than broad | 8 |
| 6. | Single ventral genital pore, rosette uterus | *Diphyllobothrium latum* |
| | Single lateral genital pore, uterus: transverse elongated sac | 7 |
| 7. | Segments less than 1 mm in breadth | *Hymenolepis nana* |
| | Segments about 2.5 mm in breadth | *Hymenolepis diminuta* |
| 8. | Uterus composed of a large number of egg's packets, bilateral genital pores | *Dipylidium caninum* |
| | Uterus with a median stem and lateral branches, single genital pore | 9 |
| 9. | Uterus with 7 to 13 lateral uterine branches per side | *Taenia solium* |
| | Uterus, with 15-30 lateral uterine branches per side | *Taeniarhynchus saginatus* |

Table 3-2. Key to important adult human cestodes.

## 3-10. COMMON PARASITES OF CLASS CESTODA

### ORGANISM 1--Diphyllobothrium latum

### GENERAL CHARACTERISTICS

COMMON NAME: Fish tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Often asymptomatic; intestinal obstruction, eosinophilia, toxemia, malnutrition, vitamin B12 deficiency, pernicious anemia.
HABITAT: Small intestines.
INTERMEDIATE HOST
FIRST: Copepod.
SECOND: Fresh water fish.
RESERVOIR HOST: Piscivores.
INFECTIVE FORM: Plerocercoid larva (sparganum).
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

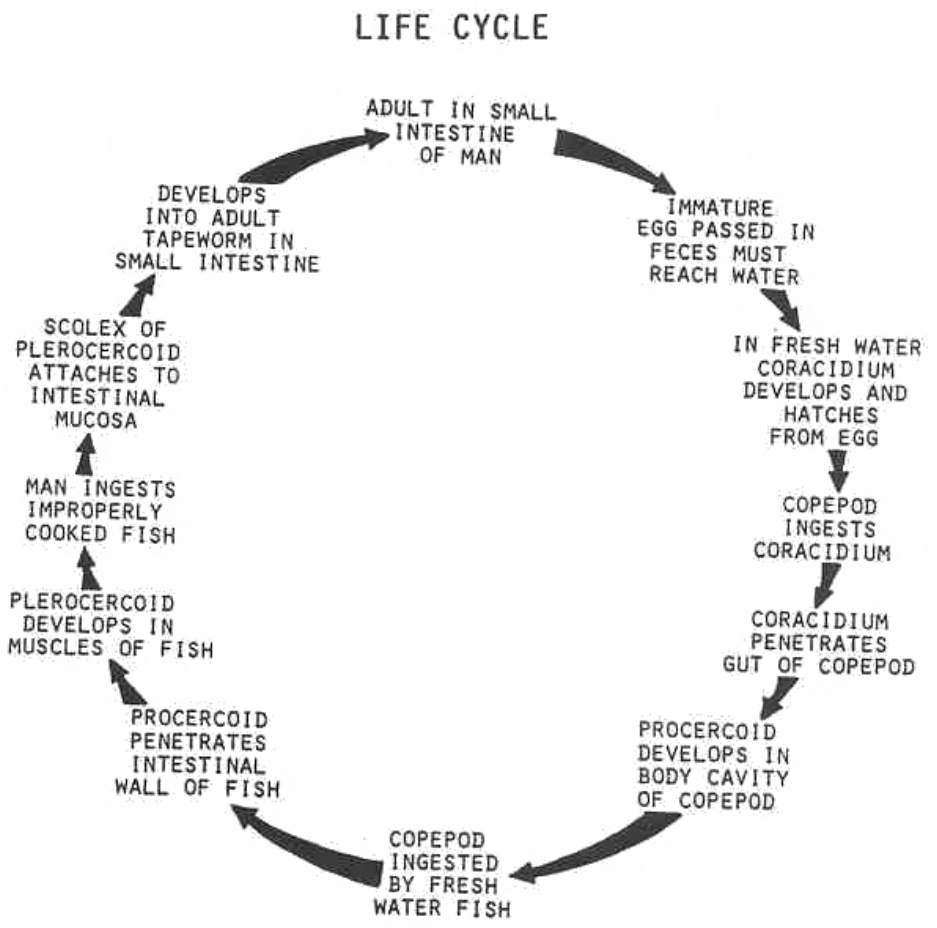
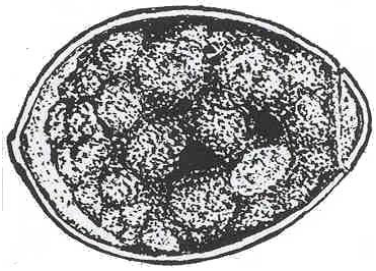

LIFE CYCLE
ADULT IN SMALL INTESTINE OF MAN
IMMATURE EGG PASSED IN FECES MUST REACH WATER
IN FRESH WATER CORACIDIUM DEVELOPS AND HATCHES FROM EGG
COPEPOD INGESTS CORACIDIUM
CORACIDIUM PENETRATES GUT OF COPEPOD
PROCERCOID DEVELOPS IN BODY CAVITY OF COPEPOD
COPEPOD INGESTED BY FRESH WATER FISH
PROCERCOID PENETRATES INTESTINAL WALL OF FISH
PLEROCERCOID DEVELOPS IN MUSCLES OF FISH
MAN INGESTS IMPROPERLY COOKED FISH
SCOLEX OF PLEROCERCOID ATTACHES TO INTESTINAL MUCOSA
DEVELOPS INTO ADULT TAPEWORM IN SMALL INTESTINE

Figure 3-38. Life cycle of Diphyllobothrium latum.

## Diphyllobothrium latum (Continued)

### OVA

SIZE: 45 x 65 mcm (medium).
SHAPE: Ovoid.
COLOR: Hyaline to light yellow.
OPERCULUM: Distinct.
CONTENTS: Yolk mass.
ABOPERCULAR PROCESS PRESENT



### ADULT

SIZE: Up to 30 meters.
COLOR: Ivory.
SCOLEX
- SIZE: 2.5 x 1.0 mm.
- SHAPE: Elliptical, spoon-shaped, almond-shape, spatulate.
- SUCKERS: longitudinal slit-like grooves (two).

PROGLOTTID
- SIZE: 2 to 4 mm by 10 to 12 mm.
- SHAPE: Rectangular, broader than long.
- GENITAL PORE: Single, ventral.
- UTERUS: Rosette-shape (highly visible).
- OVARIES: Bilobed.
- TESTES: Minute spherical.

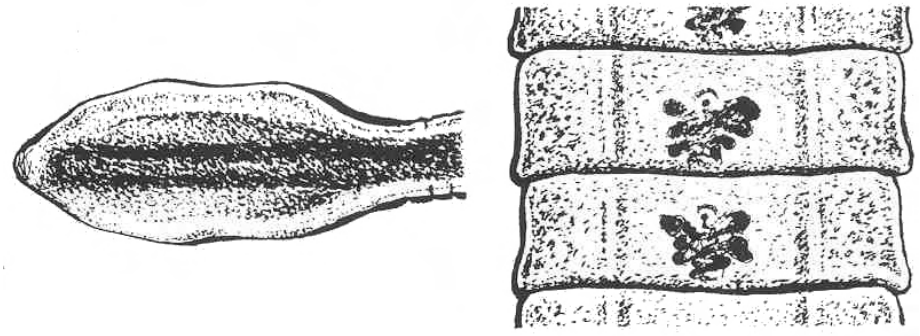


Figure 3-39. Stages of Diphyllobothrium latum.

## ORGANISM 2--Spirometra species

Organisms (plerocercoid larvae) of the genus Spirometra and also other species of Diphyllobothrium, parasites of cats and other mammals which are unable to mature in an abnormal host (man), are responsible for the disease known as sparganosis. Infections are initiated when man swallows infected copepods in drinking water which then develop into the sparganum; they may be initiated when fish, amphibians (frogs, tadpoles) or snakes are consumed raw, transferring the sparganum larva; or they may be introduced when the flesh of frogs or snakes is used as a poultice applied to a lesion or wound. As the sparganum larvae localize in the abnormal site, they cause a painful inflammatory reaction in adjacent tissues. Depending upon the site, these organisms may cause intense and serious disease processes, particularly in certain species which seem to proliferate by budding or splitting and result in many individual larvae. Diagnosis is made by recognition of larval forms from tissue biopsies.

### GENERAL CHARACTERISTICS

COMMON NAME: Sparganosis.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Inflammatory edema and necrosis of adjacent tissues; conjunctivitis; ocular inflammation; eosinophilia.
HABITAT: Small intestine of cats, dogs, tissues of man.
INTERMEDIATE HOST
FIRST: Copepod.
SECOND: Frogs, tadpoles, snakes.
ABNORMAL HOST: Man.
INFECTIVE FORM: Plerocercoid larva (sparganum).
MODE OF INFECTION: Poultices, ingestion.
SPECIMEN OF CHOICE: Biopsy.

## Spirometra species (continued)

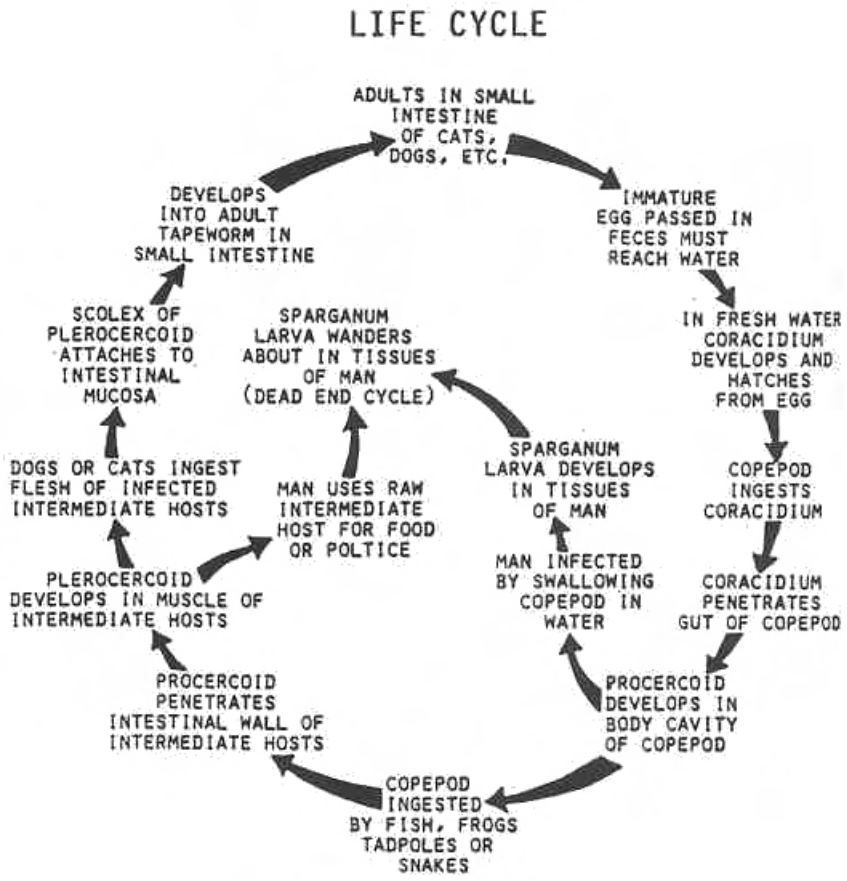

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF CATS, DOGS, ETC.
IMMATURE EGG PASSED IN FECES MUST REACH WATER
IN FRESH WATER CORACIDIUM DEVELOPS AND HATCHES FROM EGG
COPEPOD INGESTS CORACIDIUM
CORACIDIUM PENETRATES GUT OF COPEPOD
PROCERCOID DEVELOPS IN BODY CAVITY OF COPEPOD
COPEPOD INGESTED BY FISH, FROGS TADPOLES OR SNAKES
PROCERCOID PENETRATES INTESTINAL WALL OF INTERMEDIATE HOSTS
PLEROCERCOID DEVELOPS IN MUSCLE OF INTERMEDIATE HOSTS
DOGS OR CATS INGEST FLESH OF INFECTED INTERMEDIATE HOSTS
SCOLEX OF PLEROCERCOID ATTACHES TO INTESTINAL MUCOSA
DEVELOPS INTO ADULT TAPEWORM IN SMALL INTESTINE
MAN INFECTED BY SWALLOWING COPEPOD IN WATER
SPARGANUM LARVA DEVELOPS IN TISSUES OF MAN
SPARGANUM LARVA WANDERS ABOUT IN TISSUES OF MAN (DEAD END CYCLE)
MAN USES RAW INTERMEDIATE HOST FOR FOOD OR POLTICE

Figure 3-40. Life cycle of Spirometra species.

## LARVA

(in tissue section)

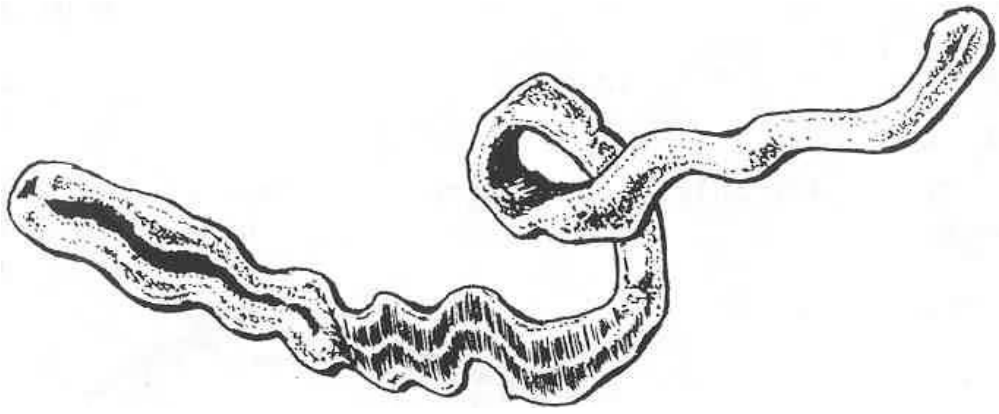


Figure 3-41. Spirometra larva.

## ORGANISM 3--Taeniarhynchus saginatus

## GENERAL CHARACTERISTICS

COMMON NAME: Beef tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Frequently asymptomic; appendiceal mucosal lesions with secondary appendicitis, rare intestinal obstruction; moderate eosinophilia.
HABITAT: Small intestines.
INTERMEDIATE HOST: Usually herbivores, mainly cattle.
RESERVOIR HOST: Man is the only basic definitive host.
INFECTIVE FORM: Cysticercus larva.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

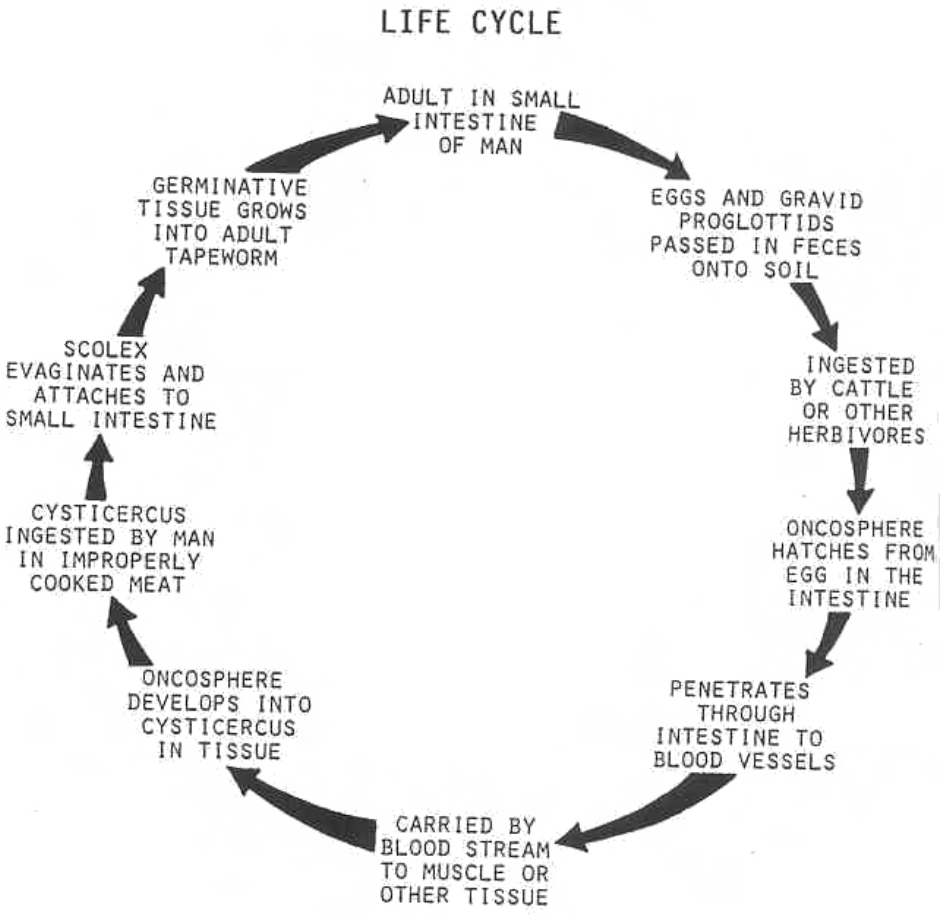
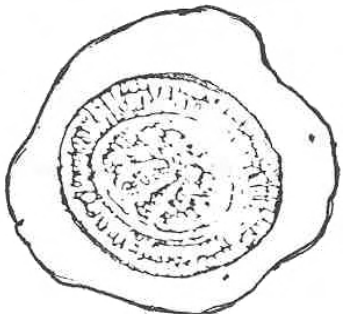

LIFE CYCLE
ADULT IN SMALL INTESTINE OF MAN
EGGS AND GRAVID PROGLOTTIDS PASSED IN FECES ONTO SOIL
INGESTED BY CATTLE OR OTHER HERBIVORES
ONCOSPHERE HATCHES FROM EGG IN THE INTESTINE
PENETRATES THROUGH INTESTINE TO BLOOD VESSELS
CARRIED BY BLOOD STREAM TO MUSCLE OR OTHER TISSUE
ONCOSPHERE DEVELOPS INTO CYSTICERCUS IN TISSUE
CYSTICERCUS INGESTED BY MAN IN IMPROPERLY COOKED MEAT
SCOLEX EVAGINATES AND ATTACHES TO SMALL INTESTINE
GERMINATIVE TISSUE GROWS INTO ADULT TAPEWORM

Figure 3-42. Life cycle of Taeniarhynchus saginatus.

## Taeniarhynchus saginatus (continued)

### OVA

SIZE: 30 to 40 mcm (small to medium).
SHAPE: Ovoid to round.
COLOR: Brown.
OPERCULUM: Absent.
Contents: Hexacanth oncosphere.
MISCELLANEOUS: Embryophore with double layer and a radially striated outer layer.



### ADULT

SIZE: 5 to 10 meters.
COLOR: Ivory.
SCOLEX
- SIZE: 1 to 2 mm in diameter, large.
- SHAPE: Round, unarmed.

PROGLOTTID
- SIZE: 5 to 7 mm by 20 mm.
- SHAPE: rectangular, longer than broad.
- GENITAL PORE: Single, lateral.
- UTERUS: Tubular when mature, gravid proglottid contains 15 to 30 branches.
- OVARIES: Two, round.
- TESTES: Minute, spherical.

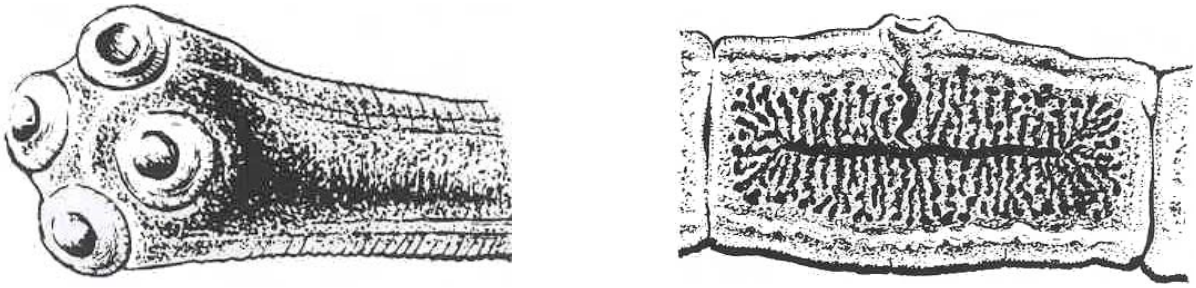


Figure 3-43. Stages of Taeniarhynchus saginatus.

## ORGANISM 4--Taenia solium

### GENERAL CHARACTERISTICS

COMMON NAME: Pork tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide
PATHOGENESIS: Inflammation of intestinal mucosa, intestinal perforation, anemia, eosinophilia, toxemia, cysticercal lesions, fibrous capsules, CNS malfunction, chorioretinitis, blindness, lesions of brain, calcification in tissues.
HABITAT: Small intestines.
INTERMEDIATE HOST
USUALLY: Swine.
CYSTICERCOSIS: Man may become the intermediate host by ingesting the egg, in which case the cysticercus larva encysts in muscle.
RESERVOIR HOST: Man is the only definitive host.
INFECTIVE: Cysticercus larva.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

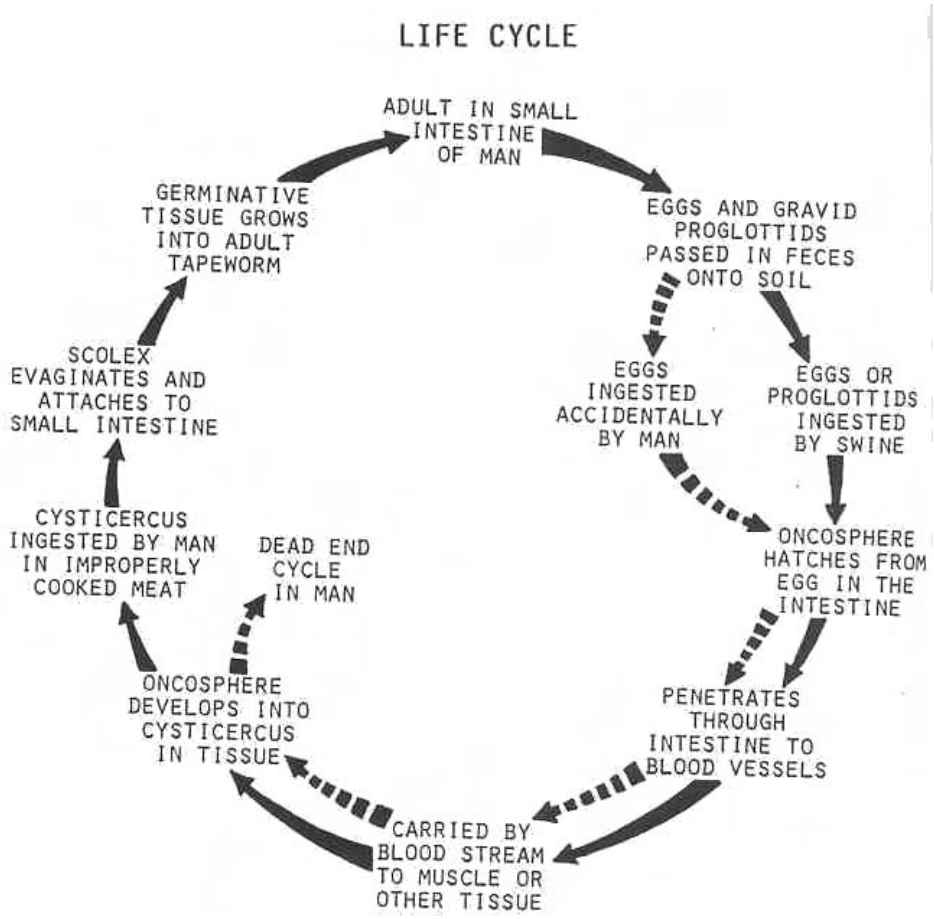
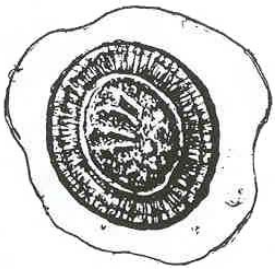

LIFE CYCLE
ADULT IN SMALL INTESTINE OF MAN
EGGS AND GRAVID PROGLOTTIDS PASSED IN FECES ONTO SOIL
EGGS INGESTED ACCIDENTALLY BY MAN
EGGS OR PROGLOTTIDS INGESTED BY SWINE
ONCOSPHERE HATCHES FROM EGG IN THE INTESTINE
PENETRATES THROUGH INTESTINE TO BLOOD VESSELS
CARRIED BY BLOOD STREAM TO MUSCLE OR OTHER TISSUE
ONCOSPHERE DEVELOPS INTO CYSTICERCUS IN TISSUE
DEAD END CYCLE IN MAN
CYSTICERCUS INGESTED BY MAN IN IMPROPERLY COOKED MEAT
SCOLEX EVAGINATES AND ATTACHES TO SMALL INTESTINE
GERMINATIVE TISSUE GROWS INTO ADULT TAPEWORM

Figure 3-44. Life cycle of Taenia solium.

## Taenia solium (continued)

### OVA

SIZE: 30 to 40 mcm (small to medium).
SHAPE: Ovoid to round.
COLOR: Brown.
OPERCULUM: Absent.
CONTENTS: Hexacanth oncosphere.
MISCELLANEOUS: Embryophore with double layer and a striated outer layer identical to the egg of T. saqinatus (eggs should be reported as being taeinoid).



### ADULT

SIZE: 2 to 7 meters.
COLOR: Ivory.
SCOLEX
- SIZE: About 1 mm, large.
- SHAPE: Round.
- ROSTELLUM: Armed with alternating circles of large and small hooklets (22-32).

PROGLOTTID
- SIZE: 4 to 7 mm by 12 mm.
- SHAPE: Rectangular, longer than broad.
- GENITAL PORE: Single, lateral.
- UTERUS: Tubular when mature, gravid. proglottid contains 7 to 13 lateral uterine branches on one side of the main stem.
- OVARIES: Two round.
- TESTES: Minute, spherical.

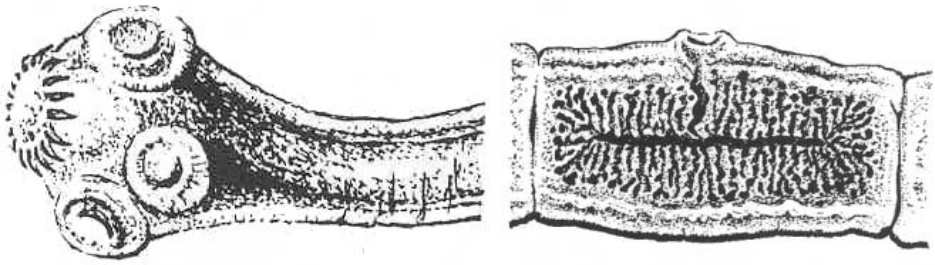


Figure 3-45. Stages of Taenia solium.

## ORGANISM 5--Hymenolepis nana

### GENERAL CHARACTERISTICS

COMMON NAME: Dwarf tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Often asymptomatic, variable enteritis, secondary anemia, eosinophilia.
HABITAT--Small intestines.
INTERMEDIATE HOST: Insects or none (autoinfective).
RESERVOIR HOST: Rodents.
INFECTIVE FORM: Cysticercoid larva.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

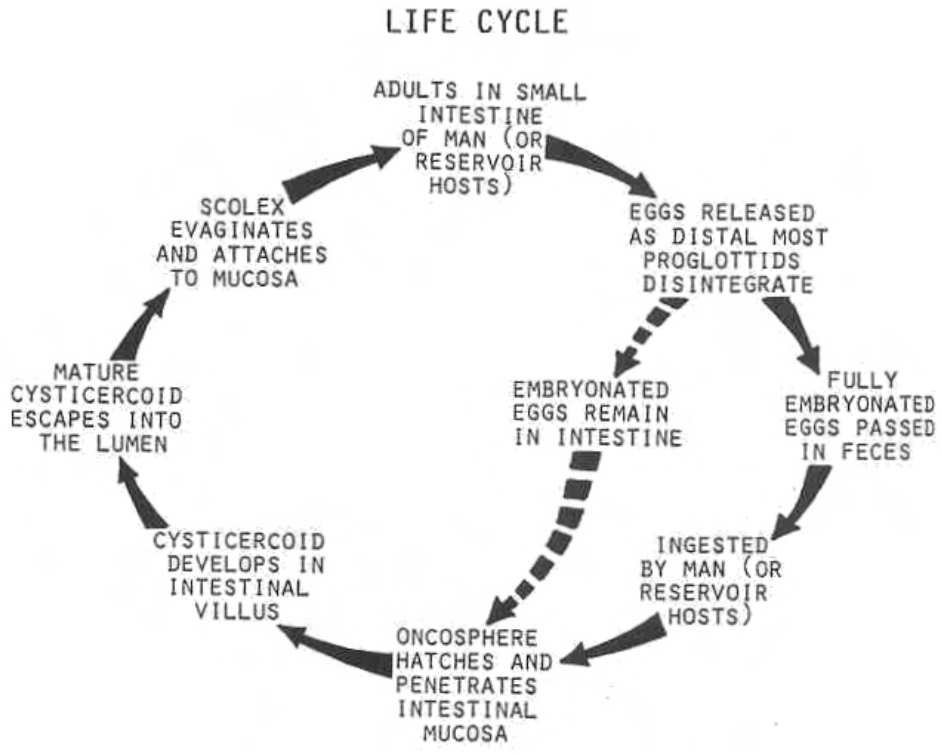
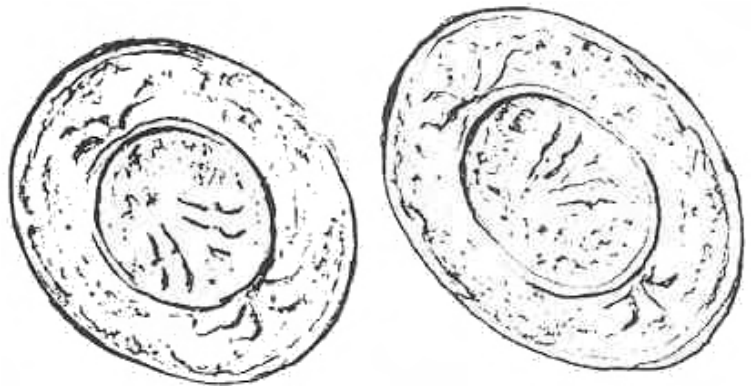

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF MAN (OR RESERVOIR HOSTS)
EGGS RELEASED AS DISTAL MOST PROGLOTTIDS DISINTEGRATE
FULLY EMBRYONATED EGGS PASSED IN FECES
EMBRYONATED EGGS REMAIN IN INTESTINE
INGESTED BY MAN (OR RESERVOIR HOSTS)
ONCOSPHERE HATCHES AND PENETRATES INTESTINAL MUCOSA
CYSTICERCOID DEVELOPS IN INTESTINAL VILLUS
MATURE CYSTICERCOID ESCAPES INTO THE LUMEN
SCOLEX EVAGINATES AND ATTACHES TO MUCOSA

Figure 3-46. Life cycle of Hymenolepis nana.

### OVA

SIZE: 35 x 45 mcm (medium).
SHAPE: Round to ovoid.
COLOR: Hyaline.
OPERCULUM: Absent.
CONTENTS: Hexacanth oncosphere.
MISCELLANEOUS: 4 to 8 bipolar filaments.

## Hymenolepis nana (Cont'd)



**ADULT**

SIZE: 7 to 40 mm, inversely proportional to the number of parasites.
COLOR: Cream.
SCOLEX
- SIZE: 0.3 mm in diameter (small).
- SHAPE: Round.
- ROSTELLUM: Retractile, armed with a row of large hooklets.

PROGLOTTID
- SIZE: Less than 1.0 mm wide.
- SHAPE: Trapezoidal, four times wider than long.
- GENITAL PORE: Single, lateral
- UTERUS: Tubular.
- OVARIES: Bilobed.
- TESTES: Three, round, and large.

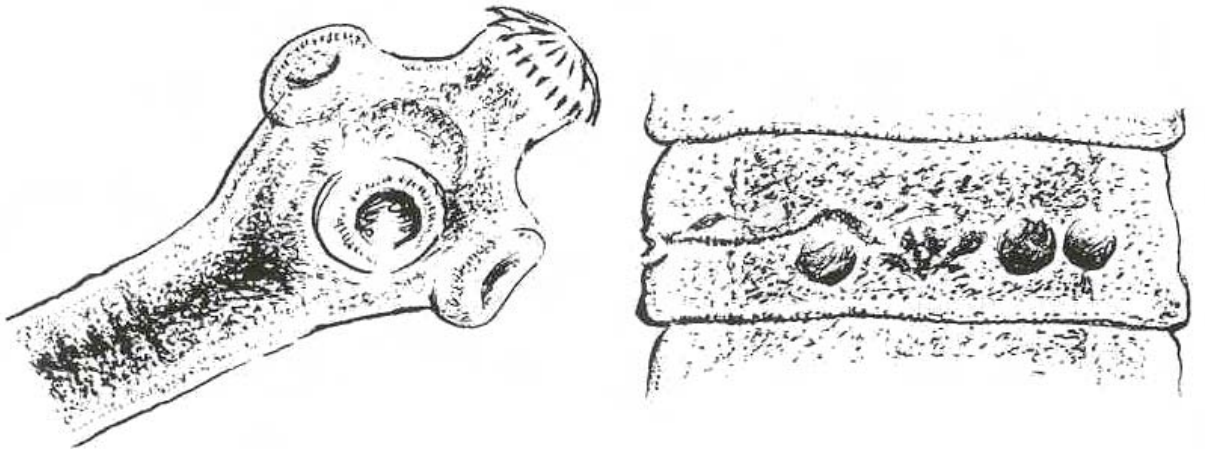


Figure 3-47. Stages of Hymenolepis nana.

## ORGANISM 6--Hymenolepis diminuta

### GENERAL CHARACTERISTICS

COMMON NAME: Rat tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: No significant pathology.
HABITAT: Small intestines.
INTERMEDIATE HOST: Insects (tenebrio molitor--grain beetle) or none (autoinfective).
RESERVOIR HOST: Rodents.
INFECTIVE FORM: Cysticercoid larva.
MODE OF ENTRY: Ingestion.
SPECIMEN SOURCE: Feces.

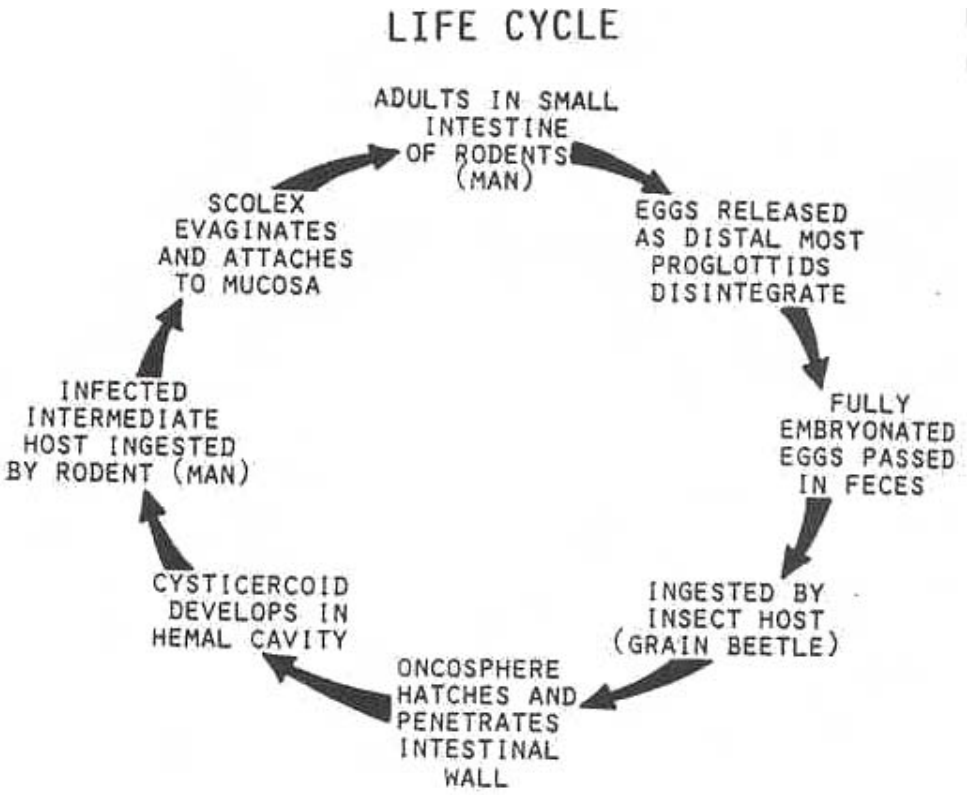

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF RODENTS (MAN)
EGGS RELEASED AS DISTAL MOST PROGLOTTIDS DISINTEGRATE
FULLY EMBRYONATED EGGS PASSED IN FECES
INGESTED BY INSECT HOST (GRAIN BEETLE)
ONCOSPHERE HATCHES AND PENETRATES INTESTINAL WALL
CYSTICERCOID DEVELOPS IN HEMAL CAVITY
INFECTED INTERMEDIATE HOST INGESTED BY RODENT (MAN)
SCOLEX EVAGINATES AND ATTACHES TO MUCOSA

Figure 3-48. Life cycle of Hymenolepis diminuta.

## Hymenolepis diminuta (continued)

### OVA

SIZE: about 70 mcm (medium to large).
SHAPE: Round to ovoid.
COLOR: Brown.
OPERCULUM: Absent.
CONTENTS: Hexacanth oncosphere.
MISCELLANEOUS: Sculptured outer shell, no bipolar filaments.

### ADULT

SIZE: 20 to 60 cm.
COLOR: Grayish white.
SCOLEX
- SIZE: 0.5 by 0.8 mm (small).
- SHAPE: Club-shaped.
- ROSTELLUM: Rudimentary, with apical process, unarmed.

PROGLOTTID
- SIZE: 2.5 mm wide.
- SHAPE: Trapezoidal.
- GENITAL PORE: Single, lateral.
- UTERUS: Tubular.
- OVARIES: Bilobed.
- TESTES: Three, round, and large.

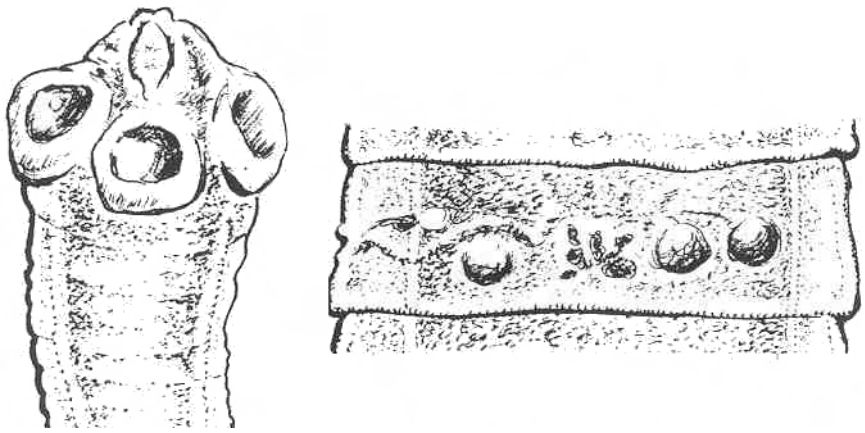


Figure 3-49. Stages of Hymenolepis diminuta.

## ORGANISM 7--Dipylidium caninum

### GENERAL CHARACTERISTICS

COMMON NAME: Dog tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: No significant pathology.
HABITAT: Small intestines.
INTERMEDIATE HOST: Fleas and lice.
RESERVOIR HOST: Dogs and cats.
INFECTIVE FORM: Cysticercoid larva.
MODE OF INFECTION: Ingestion.
SPECIMEN SOURCE: Feces.

## Dipylidium caninum (continued)

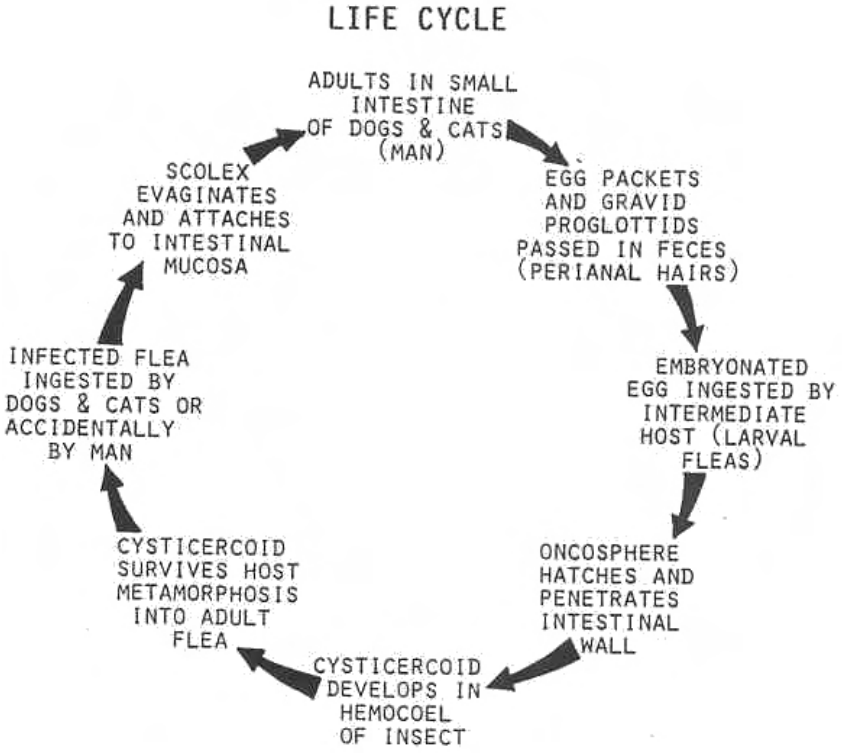
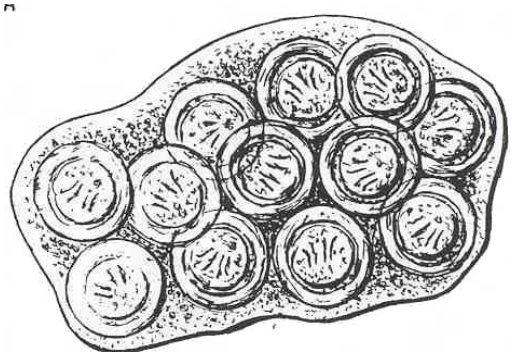

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF DOGS & CATS (MAN)
EGG PACKETS AND GRAVID PROGLOTTIDS PASSED IN FECES (PERIANAL HAIRS)
EMBRYONATED EGG INGESTED BY INTERMEDIATE HOST (LARVAL FLEAS)
ONCOSPHERE HATCHES AND PENETRATES INTESTINAL WALL
CYSTICERCOID DEVELOPS IN HEMOCOEL OF INSECT
CYSTICERCOID SURVIVES HOST METAMORPHOSIS INTO ADULT FLEA
INFECTED FLEA INGESTED BY DOGS & CATS OR ACCIDENTALLY BY MAN
SCOLEX EVAGINATES AND ATTACHES TO INTESTINAL MUCOSA

Figure 3-50. Life cycle of Dipylidium caninum.

## Dipylidium caninum (continued)

### OVA

SIZE: About 35 mcm (medium).
SHAPE: Round to ovoid.
COLOR: Light brown.
OPERCULUM: Absent.
CONTENTS: Hexacanth oncosphere.
Found in packets of 15 to 20 ova which are similar to T. saginatus but without the striated outer shell.



### ADULT

SIZE: Up to 70 cm.
COLOR: Ivory.
SCOLEX
- SIZE: 0.25 to 0.5 mm (small).
- SHAPE: Club-shaped.
- ROSTELLUM: armed with 3 to 7 rows of small hooklets.

PROGLOTTID
- SIZE: 3.2 mm wide.
- SHAPE: Longer than wide, "pumpkin seed" shape.
- GENITAL PORE: Bilateral (two).
- UTERUS: Paired with 16 to 20 radial branches each which disappear early; replaced by egg capsules.
- OVARIES: Paired.
- TESTES: Minute, spherical.

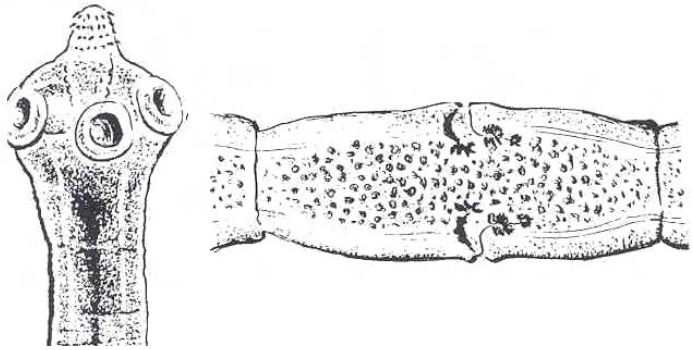


Figure 3-51. Stages of Dipylidium caninum.

## ORGANISM 8--Echinococcus granulosus

### GENERAL CHARACTERISTICS

COMMON NAME: Hydatid cyst tapeworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide
PATHOGENESIS: Varies with location of cysts, inflammation reactions, fibrous cysts, pressure necrosis of adjacent tissue, hepatic cysts often in right lobe; cysts also in lung, kidneys, bones, brain, and other organs; secondary infections; eosinophilia.
HABITAT: Intestine of canines (adult worm); soft tissue and bones of intermediate host (larval stage).
INTERMEDIATE HOST: Man and herbivores, sheep.
RESERVOIR HOST: Carnivores (dogs).
INFECTIVE FORM: Egg for intermediate hosts; protoscolices for dogs or other canines.
MODE OF INFECTION: Ingestion.
SPECIMEN SOURCE: Dog feces or tissue (surgical).

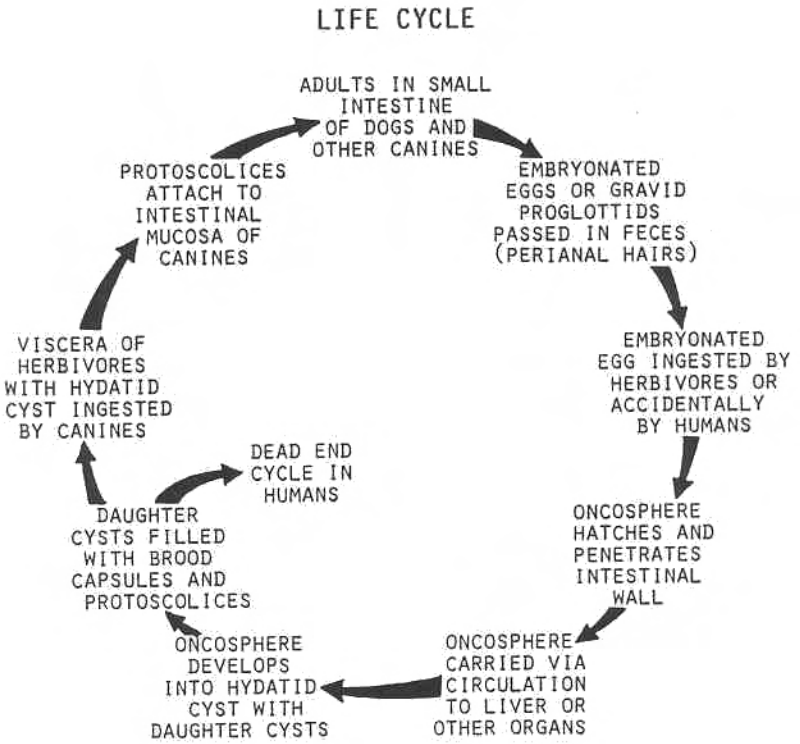

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF DOGS AND OTHER CANINES
EMBRYONATED EGGS OR GRAVID PROGLOTTIDS PASSED IN FECES (PERIANAL HAIRS)
EMBRYONATED EGG INGESTED BY HERBIVORES OR ACCIDENTALLY BY HUMANS
ONCOSPHERE HATCHES AND PENETRATES INTESTINAL WALL
ONCOSPHERE CARRIED VIA CIRCULATION TO LIVER OR OTHER ORGANS
ONCOSPHERE DEVELOPS INTO HYDATID CYST WITH DAUGHTER CYSTS
DAUGHTER CYSTS FILLED WITH BROOD CAPSULES AND PROTOSCOLICES
DEAD END CYCLE IN HUMANS
VISCERA OF HERBIVORES WITH HYDATID CYST INGESTED BY CANINES
PROTOSCOLICES ATTACH TO INTESTINAL MUCOSA OF CANINES

Figure 3-52. Life cycle of Echinococcus granulosus.

## Echinococcus granulosus (Continued)

### OVA

SIZE: 30 to 40 mcm.
SHAPE: Ovoid to round.
COLOR: Brown.
OPERCULUM: Absent.
CONTENTS: Hexacanth oncosphere.
MISCELLANEOUS: Embryophore with double layer and a striated outer layer; indistinguishable from taenioid ova.

### ADULT

SIZE: 3 to 6 mm.
COLOR: Grayish white.
SCOLEX
- SIZE: 0.3 mm.
- SHAPE: Pyriform.
- ROSTELLUM: Armed with 28 to 50 hooklets.

PROGLOTTID
- USUALLY THREE: Immature, mature, and gravid.
- SIZE: 1.3 to 2.5 mm by 0.5 mm.
- SHAPE: Longer than broad.
- GENITAL PORE: Lateral, single, equatorial.
- UTERUS: Irregular longitudinal sac.
- OVARIES: Two, oval.
- TESTES: Minute, spherical (45 to 60).

Figure 3-53. Stages of Echinococcus granulosus. (continued)

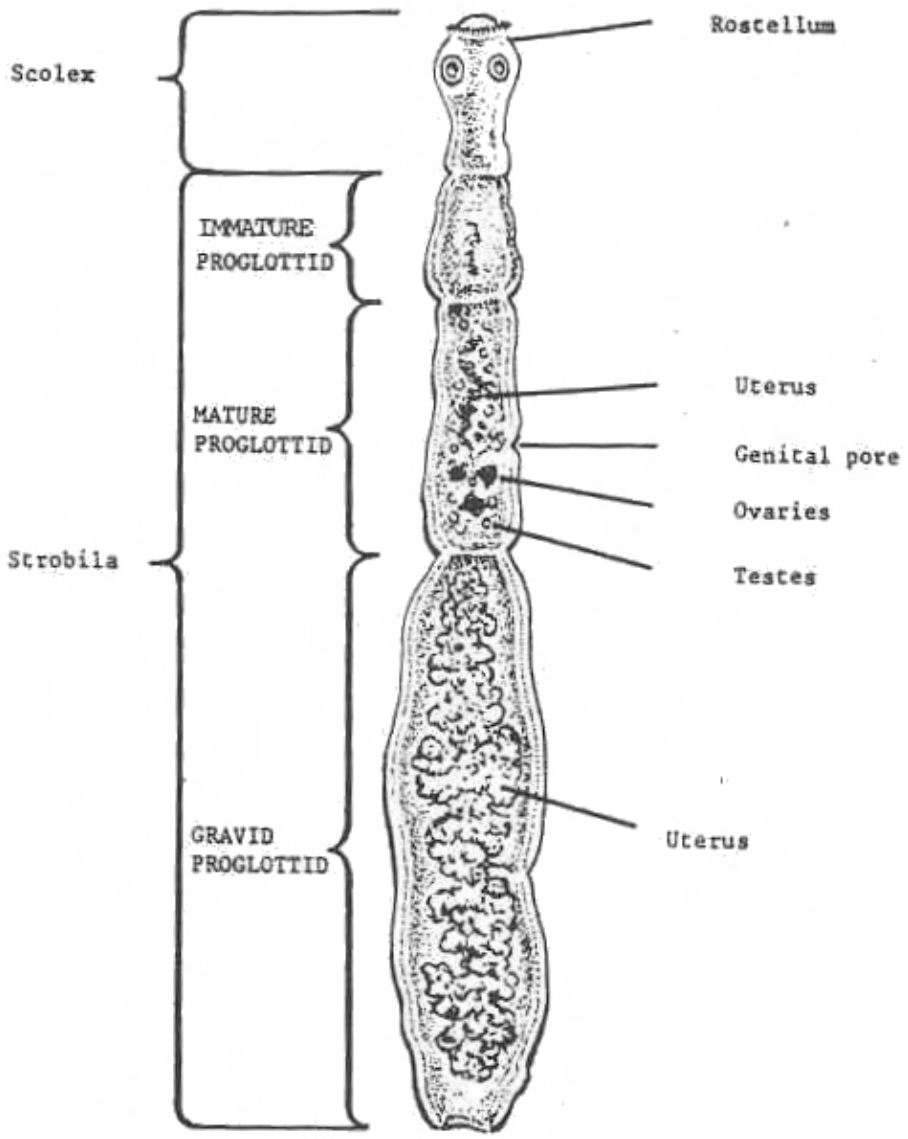



Figure 3-53. Stages of Echinococcus granulosus. (concluded)

## ORGANISM 9--Echinococcus multilocularis

### GENERAL CHARACTERISTICS

COMMON NAME: Hydatid cyst tapeworm.
GEOGRAPHICAL DISTRIBUTION: Northern Hemisphere, in cold or arctic climates.
PATHOGENESIS: Varies with location of cyst; inflammatory reactions; fibrous cysts; hemorrhages; cyst pressure; necrosis of adjacent tissues; hepatic cysts often inthe right lobe; cysts also in lung, kidneys, bones, brain and other organs; may metastasize like a cancer; secondary infections; eosinophilia; grave prognosis.
HABITAT: Intestine of canines (adult worm); soft tissue and bones of intermediate hosts (larval stage).
INTERMEDIATE HOST: Man and mice, moles and herbivores.
RESERVOIR HOST: Carnivores (dogs).
INFECTIVE FORM: Egg for intermediate hosts; protoscolices for dogs or other canines.
MODE OF INFECTION: Ingestion.
SPECIMEN SOURCE: Dog feces or tissue (surgical).

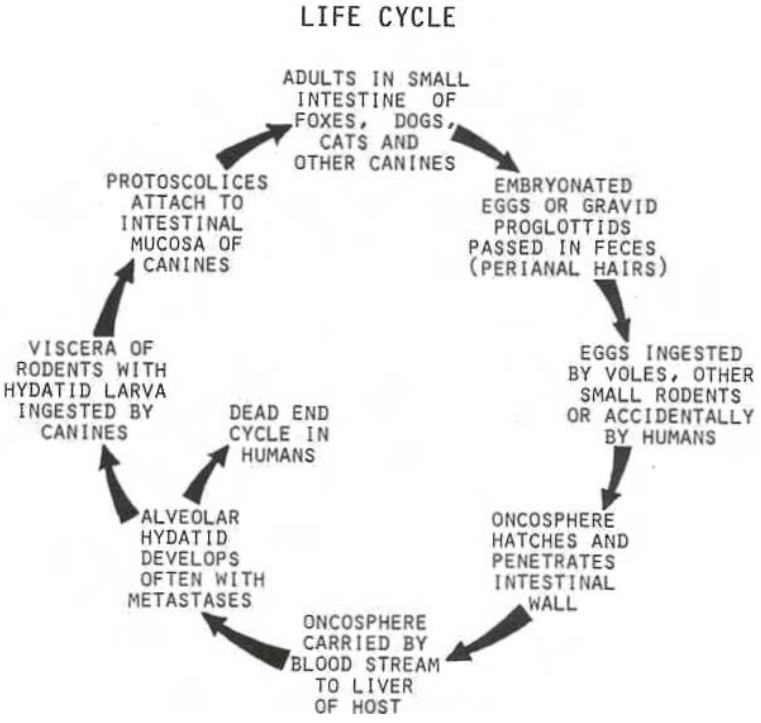

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF FOXES, DOGS, CATS AND OTHER CANINES
EMBRYONATED EGGS OR GRAVID PROGLOTTIDS PASSED IN FECES (PERIANAL HAIRS)
EGGS INGESTED BY VOLES, OTHER SMALL RODENTS OR ACCIDENTALLY BY HUMANS
ONCOSPHERE HATCHES AND PENETRATES INTESTINAL WALL
ONCOSPHERE CARRIED BY BLOOD STREAM TO LIVER OF HOST
ALVEOLAR HYDATID DEVELOPS OFTEN WITH METASTASES
DEAD END CYCLE IN HUMANS
VISCERA OF RODENTS WITH HYDATID LARVA INGESTED BY CANINES
PROTOSCOLICES ATTACH TO INTESTINAL MUCOSA OF CANINES

Figure 3-54. Life cycle of Echinococcus multilocularis.

## Echinococcus multilocularis (continued)

### OVA

SIZE: 30 to 40 mcm.
SHAPE: Ovoid to round.
COLOR: Brown.
OPERCULUM: Absent.

CONTENTS: Hexacanth oncosphere.
MISCELLANEOUS: Embryophore with double layer and a striated outer layer; indistinguishable from taenioid ova.

### ADULT

SIZE: 1.2 to 3.7 mm by 0.3 mm.
COLOR: Ivory.
SCOLEX
- SIZE: 0.1 mm.
- SHAPE: Pyriform.
- ROSTELLUM: Armed with 30 to 36 hooklets.

PROGLOTTID
- USUALLY THREE: immature, mature, and gravid.
- SIZE: 0.1 mm by 0.4 mm.
- SHAPE: Longer than broad.
- GENITAL PORE: Lateral; preequatorial.
- UTERUS: Longitudinal sac.
- OVARIES: Two, oval.
- TESTES: Minute, spherical (15 to 30).

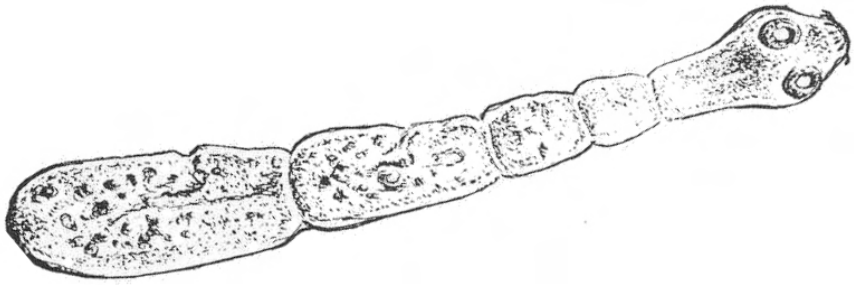
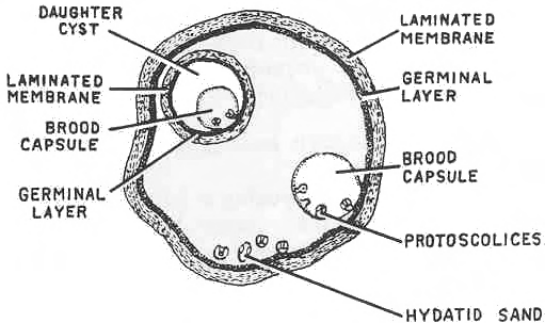


Figure 3-55. Stages of Echinococcus multilocularis. (continued)

## Echinococcus multilocularis (continued)

### UNILOCULAR CYST

CHARACTERISTIC OF E. granulosus
SIZE: Up to 200 mm.
CYST WALL: Limiting membrane.
THICK OUTER: Laminated acellular layer.
THIN INNER: Nucleated germinal layer.
PROTOSCOLICES: Miniature invaginated scolices on germinal layer of cyst wall.
BROOD CAPSULES: Formed from germinal layer; contain protoscolices.
DAUGHTER CYSTS: Replica of mother cyst, formed as germinal cells penetrate laminated layer; contain protoscolices and brood capsules (rarely seen with this organism).




### MULTILOCULAR CYST

CHARACTERISTIC OF E. multilocularis
SIZE: Usually poorly defined.
CYST WALL: Unlimiting membrane.
THIN OUTERvOutgrowing processes of germinal cells.
PROTOSCOLICES: Miniature invaginated scolices; formed in fluid-filled pockets; few in number in human infections.
BROOD CAPSULES: Absent.
DAUGHTER CYSTS: Replica of mother cyst, formed as alveolar pockets separate from the cyst wall; numerous in number and frequency; direct metastases.

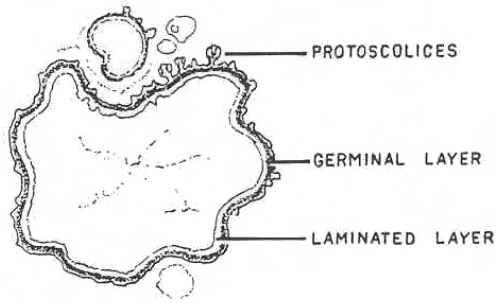



Figure 3-55. Stages of Echinococcus multilocularis. (concluded)

**Continue with Exercises**

**EXERCISES, LESSON 3**

**INSTRUCTIONS:** Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. The definitive host for Taeniarhynchus saginatus is/are:

   a. Man.

   b. Piscivores.

   c. Rodents.

   d. Carnivores.

2. The common name for members of the Class Cestoda is:

   a. Blood fluke.

   b. Fluke.

   c. Roundworm.

   d. Tapeworm.

3. What is the habitat of Schistosoma haemotobium?

   a. Venules surrounding the small intestines.

   b. Small intestine.

   c. Liver.

   d. Venules surrounding urinary bladder.

4. If you recover a scolex which is armed and has four round suckers, you would report:

   a. Taeniarhynchus saginatus.

   b. Taenia solium.

   c. Diphyllobothrium latum.

   d. None of the above.

5. The subclass of flukes which contains members parasitic to humans is:

   a. Monogenea.

   b. Digenea.

   c. Aspidobothria.

   d. Prosostomatea.

6. The structure in which the internal organs of Platyhelminthes are embedded is the:

   a. Flame cell.

   b. Ganglion.

   c. Parenchyma.

   d. Proglottid.

7. Members of the Class Cestoda have a highly developed _____system.

   a. Digestive.

   b. Respiratory.

   c. Reproductive.

   d. Muscular.

8. The specimen of choice for recovery of Paragonimus westermani is:

    a. Lung biopsy.

    b. Urine.

    c. Tissue.

    d. Sputum.

9. The adult form of Fasciola hepatica is distinguished by:

    a. Large size.

    b. A prominent cephalic cone.

    c. Highly branched digestive ceca.

    d. All of the above.

10. The form of Echinococcus multilocularis which is responsible for infecting man is the:

    a. Hydatid larva.

    b. Ovum.

    c. Protoscolex.

    d. Adult.

11. Which of the following structures is helpful when identifying ova of Opisthorchis sinensis?

    a. Thickening of the abopercular end.

    b. Abopercular comma.

    c. Operculated at the broadest end.

    d. All of the above.

12. Which of the following terms is one of the general characteristics of flukes?

    a. Polyzoic.

    b. Segmented.

    c. Monozoic.

    d. None of the above.

13. Clinical data reveals that _____ produces the most embolic eggs and more severe lesions in man.

    a. Schistosoma japonicum.

    b. Avian Schistosoma.

    c. Schistosoma mansoni.

    d. Schistosoma haemotobium.

14. Infections of Schistosoma mansoni are acquired by:

    a. Ingestion of the mature egg.

    b. Consumption of infected fish.

    c. Active penetration of the cercaria larva.

    d. Drinking water containing metacercaria larva.

15. Second intermediate hosts of the Opisthorchis species are:

    a. Pigs.

    b. Aquatic plants.

    c. Crabs and crayfish.

    d. Fish.

16. The testes of Dicrocoelium dendriticum are:

    a. Highly dendritic.

    b. In the posterior half of the body.

    c. In the anterior half of the body.

    d. Tandem in position.

17. The adults of Fasciolopsis buski can be readily distinguished from Fasciola hepatica by:

    a. The undulating ceca.

    b. The lack of a cephalic cone.

    c. The flushy color of the body.

    d. All of the above.

18. What is the habitat of Metagonimus yokogawai?

    a. Liver.

    b. Small intestine.

    c. Lungs.

    d. Large intestine.

19. Which of the following flukes has an off-set gonotyl as one of the distinguishing characteristics?

    a. Schistosoma species.

    b. Heterophyes heterophyes.

    c. Dicrocoelium dendriticum.

    d. Metagonimus yokogawai.

20. Hogs and the Napu mouse deer are the reservior hosts for:

    a. Paragonimus westermani.

    b. Opisthorchis sinensis.

    c. Gastrodiscoides hominis.

    d. Echinostoma species.

21. The terminal (distal) segments of a tapeworm are called:

    a. Gravid proglottids.

    b. Gonopores.

    c. Mature proglottids.

    d. Strobila.

22. The infective form of Diphyllobothrium latum ingested with improperly cooked fish is the:

    a. Plerocercoid.

    b. Cysticercoid.

    c. Procercoid.

    d. Cysticercus.

23. The scolex of Hymenolepis nana could be described as being:

    a. Armed with a row of hooklets on a retractile rostellum.

    b. Unarmed with an apical process.

    c. Armed with 3-7 rows of hooklets.

    d. Unarmed with no rostellum.

24. Which of the organisms listed below is the rat tapeworm?

    a. Diphyllobothrium latum.

    b. Hymenolepis diminuta.

    c. Dipylidium caninum.

    d. Hymenolepis nana.

25. Egg packets containing 15 to 20 eggs are significant for:

    a. Echinococcus granulosus.

    b. Dipylidium caninum.

    c. Spirometra species.

    d. Diphyllobothrium latum.

26. The specimen source for the recovery of Echinococcus species is:

    a. Canine feces.

    b. Bone marrow.

    c. Tissue biopsies.

    d All of the above.

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 3

1. a (para 3-10; org 3)
2. d (para 3-8)
3. d (para 3-7; org 3)
4. b (para 3-10; org 4)
5. b (para 3-6)
6. c (para 3-2)
7. c (para 3-8)
8. d (para 3-7; org 4)
9. d (para 3-7; org 8)
10. b (para 3-10; org 9)
11. b (para 3-7; org 5;)
12. c (para 3-5)
13. a (para 3-7; org 1)
14. c (para 3-7; org 2)
15. d (para 3-7; org 6)
16. c (para 3-7; org 7)
17. d (para 3-7; org 9)
18. b (para 3-7; org 10)
19. b (para 3-7; org 11)
20. c (para 3-7; org 12)
21. a (para 3-9; figure 3-36)
22. a (para 3-10; org 1)

23. a (para 3-10; org 5)

24. b (para 3-10; org 6)

25. b (para 3-10; org 7)

26. d (para 3-10; org 8 & 9)

**End of Lesson 3**

## LESSON ASSIGNMENT

| | |
|---|---|
| **LESSON 4** | Phylum Aschelminthes; Phylum Acanthocephelminthes; Arthropods and Vectors |
| **LESSON ASSIGNMENT** | Para 4-1 through 4-7. |
| **LESSON OBJECTIVES** | After completing this lesson, you should be able to: |

4-1. Identify the general characteristics of members of Phylum Aschelminthes.

4-2. Identify the organism characteristics of members of Class Nematoda that are parasitic to human intestines.

4-3. Select a statement that best describes the life cycle of an intestinal nematode.

4-4. Identify the organism characteristics of tissue-dwelling Nematodes.

4-5. Select a statement that best describes the life cycle of a tissue dwelling Nematode.

4-6. Identify the organism characteristics of nematodes that are parasitic to human blood and tissue.

4-7. Select a statement that best describes the life cycle of a blood or tissue Nematode.

4-8. Identify the specimen of choice for recovery of specific Nematodes.

4-9. Identify the special techniques for recovery of specific Nematodes.

4-10. Identify general characteristics of members of Phylum Acanthocephelminthes.

4-11. Select a statement that best describes the life cycle of a pathogenic Acanthocephalan.

4-12. Identify the morphological characteristics of arthropod and vectors.

**SUGGESTION**

After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

# LESSON 4

# PHYLUM ASCHELMINTHES; PHYLUM ACANTHOCEPHELMINTHES; ARTHROPODS AND VECTORS

## Section I: PHYLUM ASCHELMINTHES

### 4-1. GENERAL COMMENTS

This phylum consists of thousands of free living and parasitic species. They are round with tapering ends and unsegmented. Members of this phylum have been found to be parasitic in nearly every type of organism and in every system of the body. All of the human parasitic round worms belong to the class Nematoda. The life cycle of nematodes varies from simple autoinfection to a complicated cycle that carries the larval organism through different systems of the host before arriving at the natural habitat. Reproduction is sexual and two organisms, one of each sex, are required (dioecious). The female is considerably larger than the male, and the males have curved tails and/or specialized copulatory organs that aid in grasping the female for copulation. The outer covering, the cuticle, is relatively impermeable, used for protection, and molting from one larval stage to another begins here. The digestive tract is complete and consists of a mouth, a specialized pharyngeal area, intestines, rectum, and an anus. These organisms possess a sophisticated osmoregulatory/excretory system based on ammonia waste that exits through the anus. Some species may have excretory pores and/or renette glands. The nervous system consists of two nerve rings (anterior and posterior) that lead to receptors (sense organs) for light, chemical, and mechanical stimulation, and a pair of longitudinal nerves located laterally.

### 4-2. NEMATODE GROUPS

Nematodes parasitic to man can be grouped according to life cycles, as; A. Intestinal Nematodes, B. Tissue Dwelling Nematodes, and C. Blood and Tissue Nematodes.

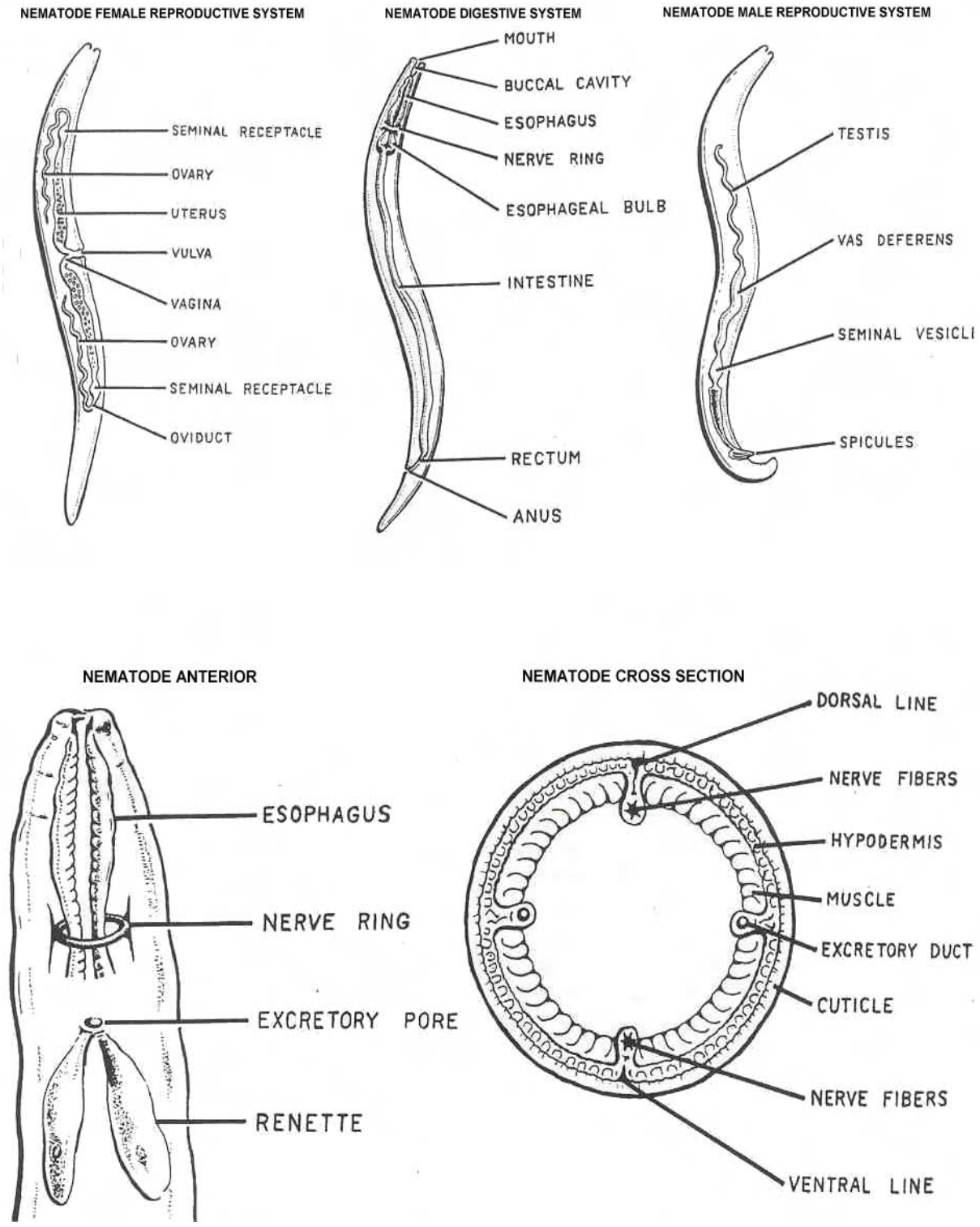



Figure 4-1. Typical nematode.

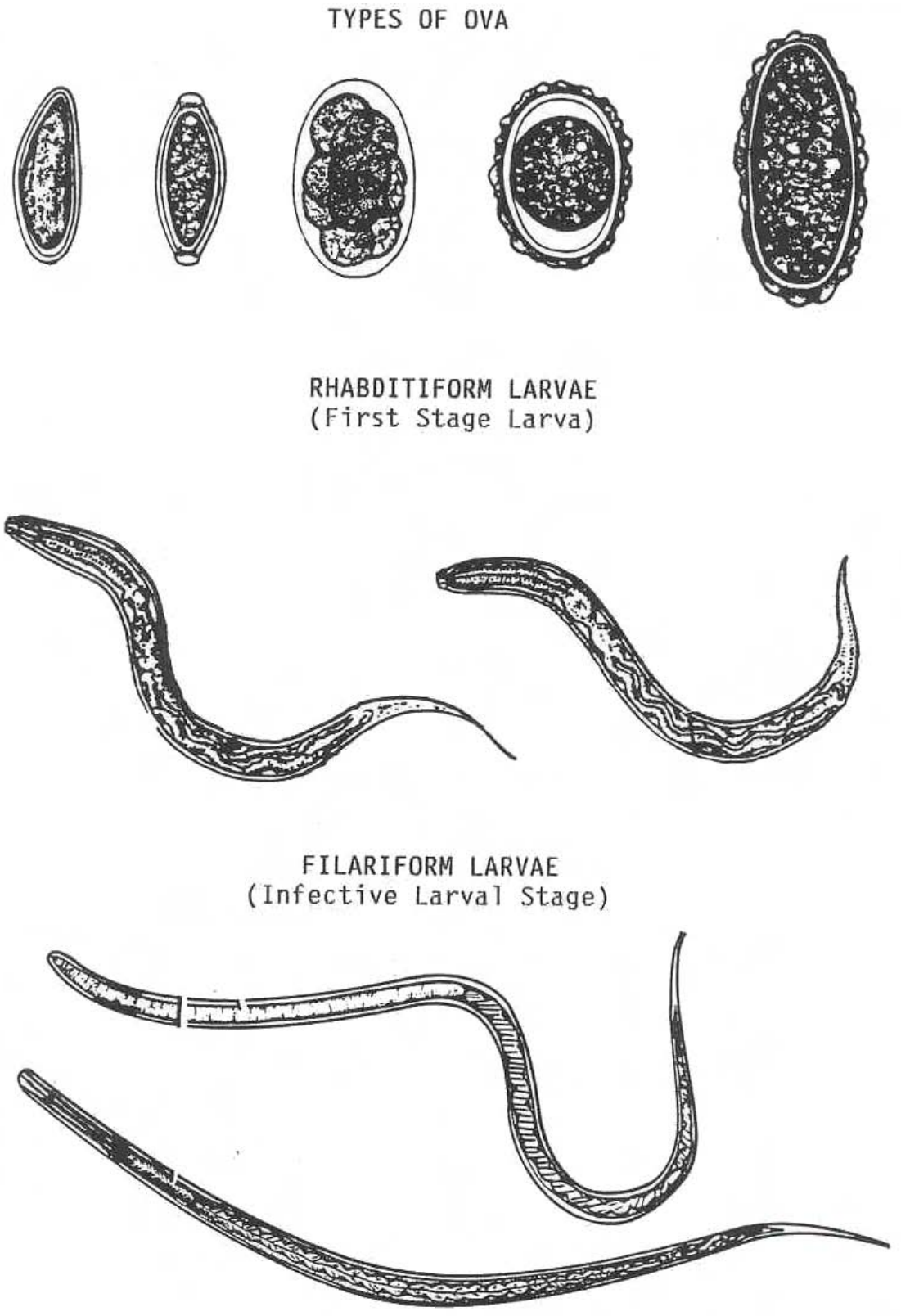



Figure 4-2. Nematode ova and larval stages.

A. **Intestinal Nematodes.**

## ORGANISM 1 Ascaris lumbricoides

COMMON NAME: Giant intestinal roundworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PREVALENCE: Most prevalent helminth infection, 25 %of lumen helminthiasis.
PATHOGENESIS: Enteritis, inflammation, obstruction, toxicity, eosinophilia, hemmorrhage, trauma by penetrating adults.
HABITAT: Small intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Swine.
INFECTIVE FORM: Embryonated egg.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

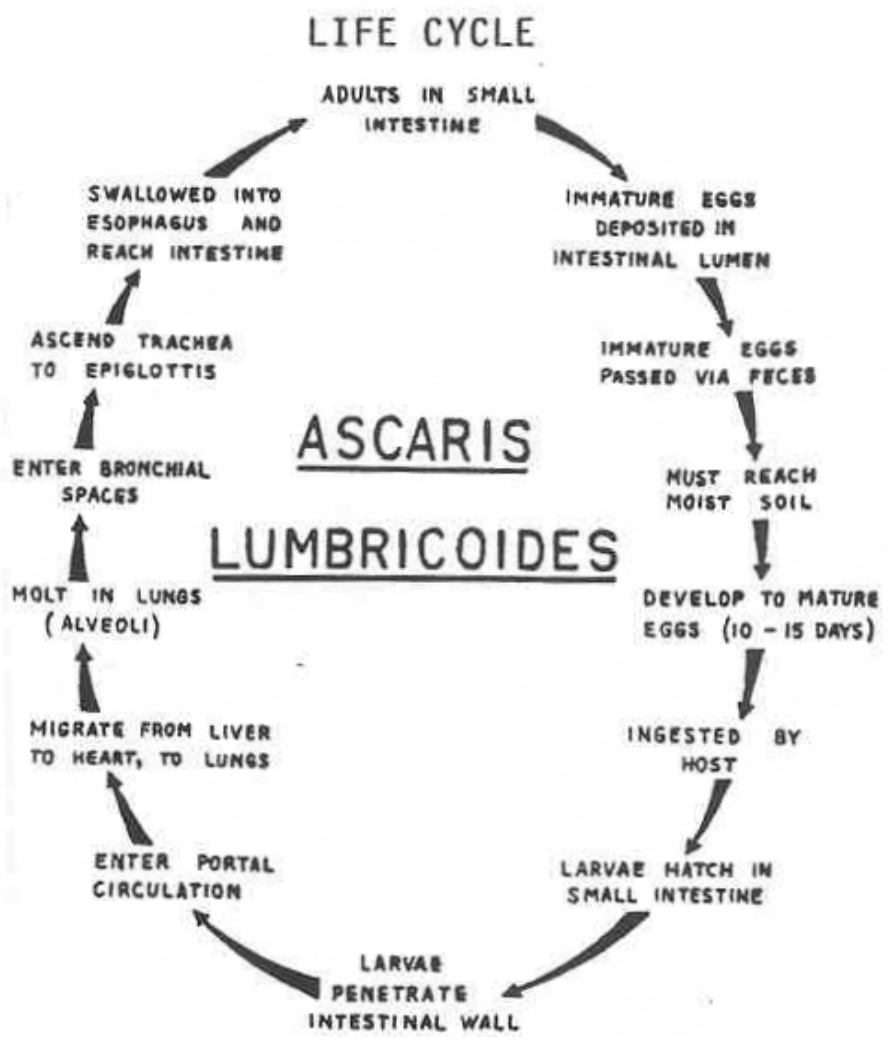

LIFE CYCLE
ADULTS IN SMALL INTESTINE
IMMATURE EGGS DEPOSITED IN INTESTINAL LUMEN
IMMATURE EGGS PASSED VIA FECES
MUST REACH MOIST SOIL
DEVELOP TO MATURE EGGS (10 - 15 DAYS)
INGESTED BY HOST
LARVAE HATCH IN SMALL INTESTINE
LARVAE PENETRATE INTESTINAL WALL
ENTER PORTAL CIRCULATION
MIGRATE FROM LIVER TO HEART, TO LUNGS
MOLT IN LUNGS (ALVEOLI)
ENTER BRONCHIAL SPACES
ASCEND TRACHEA TO EPIGLOTTIS
SWALLOWED INTO ESOPHAGUS AND REACH INTESTINE
ASCARIS
LUMBRICOIDES

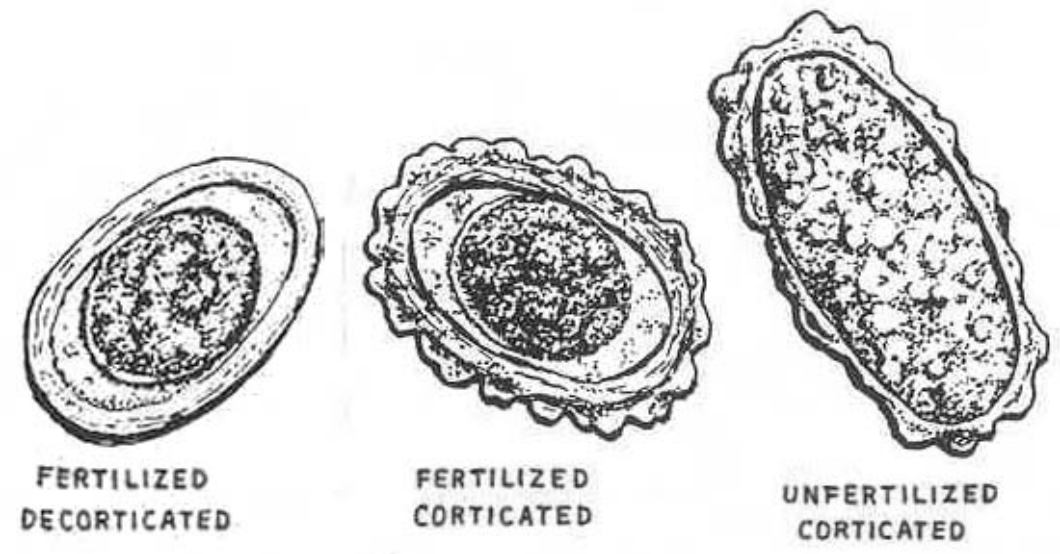
Figure 4-3. Life cycle of Ascaris lumbricoides.

## Ascaris lumbricoides (continued)

### OVA

DECORTICATED
- SIZE: 35 x 50 mcm.
- SHAPE: Oval to round.
- COLOR: Hyaline.
- OPERCULUM: None.

CORTICATED
- SIZE: 45 x 60 mcm.
- SHAPE: Oval, elongated, somewhat rectangular.
- COLOR: Brown cortication, hyaline shell wall.
- OPERCULUM: None.
- CONTENT: Yolk mass.
- FERTILIZED: Organized; pulled away from wall.
- UNFERTILIZED: Disorganized; fills the shell.




### ADULT

SIZE
- MALE: 15 to 30 cm.
- FEMALE: 20 to 35 cm.

SHAPE: Round and slender, male has curved tail.
COLOR: Creamy-white with a pinkish cast.
BUCCAL STRUCTURES: Three lips.

Figure 4-4. Stages of Ascaris lumbricoides. (continued)

## Ascaris lumbricoides (continued)

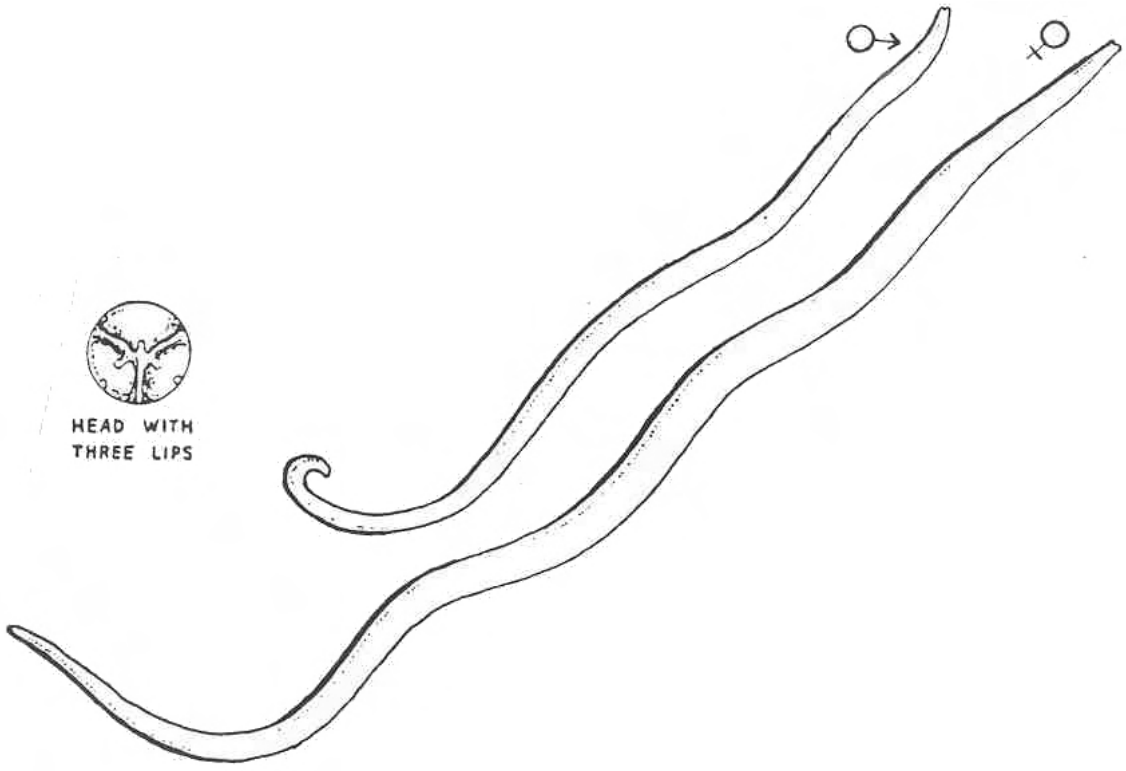



Figure 4-4. Stages of Ascaris lumbricoides. (concluded)

## ORGANISM 2 Trichuris trichiura

### GENERAL CHARACTERISTICS

COMMON NAME: Whipworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Eosinophilia, severe anemia, hemorrhage, rectal prolapse in extreme cases.
HABITAT: Large intestines, cecum.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Monkey, swine.
INFECTIVE FORM: Embryonated egg.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

## Trichuris trichiura (continued)

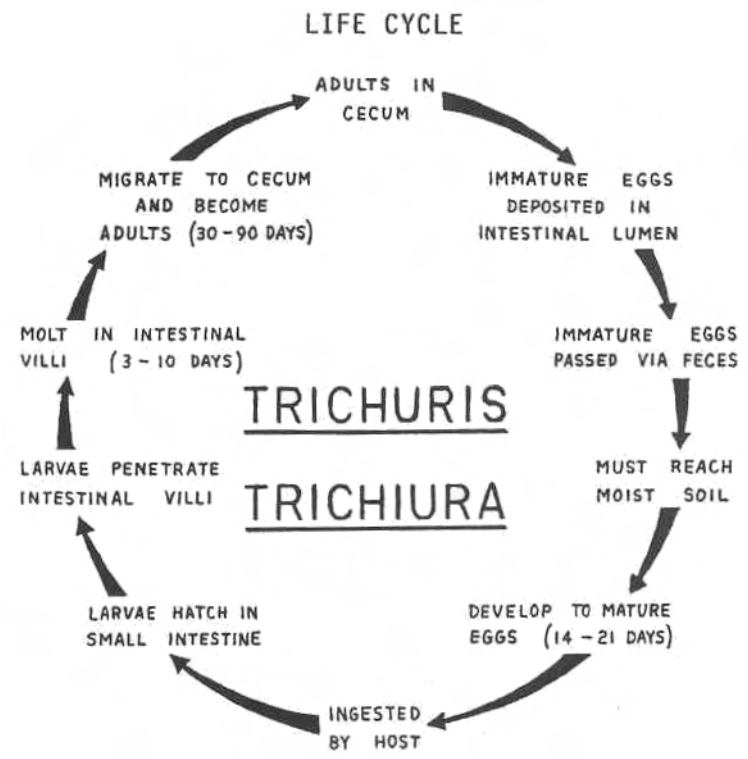

LIFE CYCLE
ADULTS IN CECUM
IMMATURE EGGS DEPOSITED IN INTESTINAL LUMEN
IMMATURE EGGS PASSED VIA FECES
MUST REACH MOIST SOIL
DEVELOP TO MATURE EGGS (14 – 21 DAYS)
INGESTED BY HOST
LARVAE HATCH IN SMALL INTESTINE
LARVAE PENETRATE INTESTINAL VILLI
MOLT IN INTESTINAL VILLI (3 – 10 DAYS)
MIGRATE TO CECUM AND BECOME ADULTS (30 – 90 DAYS)
TRICHURIS
TRICHIURA

Figure 4-5. Life cycle of Trichuris trichiura.

## Trichuris trichiura (continued)

### OVA

SIZE: 20 x 55 mcm.
SHAPE: Football, barrel-shape with bipolar plugs.
COLOR: Golden brown.
OPERCULUM: Absent.
CONTENT: Yolk mass (rare larva seen).

Figure 4-6. Stages of Trichuris trichiura. (continued)

### ADULT

SIZE
MALE: 30 to 45 mm.
FEMALE: 35 to 50 mm.
SHAPE: Thick posterior and whip-like anterior.
COLOR: Flesh-colored.

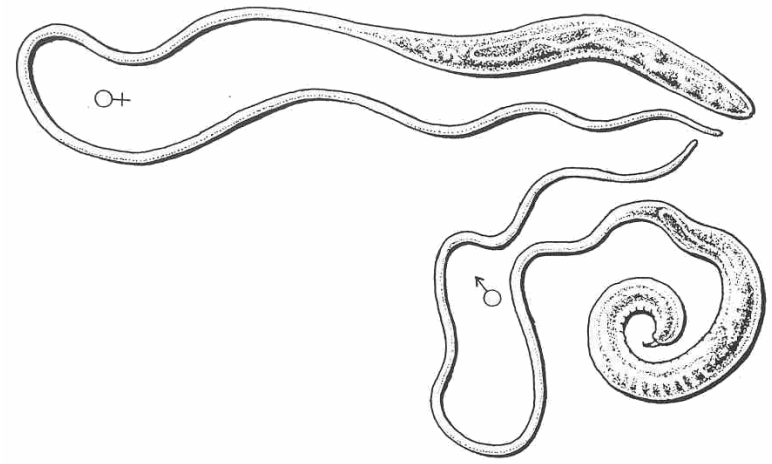


Figure 4-6. Stages of Trichuris trichiura. (concluded)

## ORGANISM 3 Enterobius vermicularis

### GENERAL CHARACTERISTICS

COMMON NAME: Pinworm, seatworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide
PATHOGENESIS: Slight eosinophilia (4 to 12 percent); secondary infections, perianai irritations.
HABITAT: Large intestine, cecum.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None known.
INFECTIVE FORM: Embryonated egg (Rhabditiform larva).
SPECIMEN SOURCE: Perianal swab or "scotch tape prep."

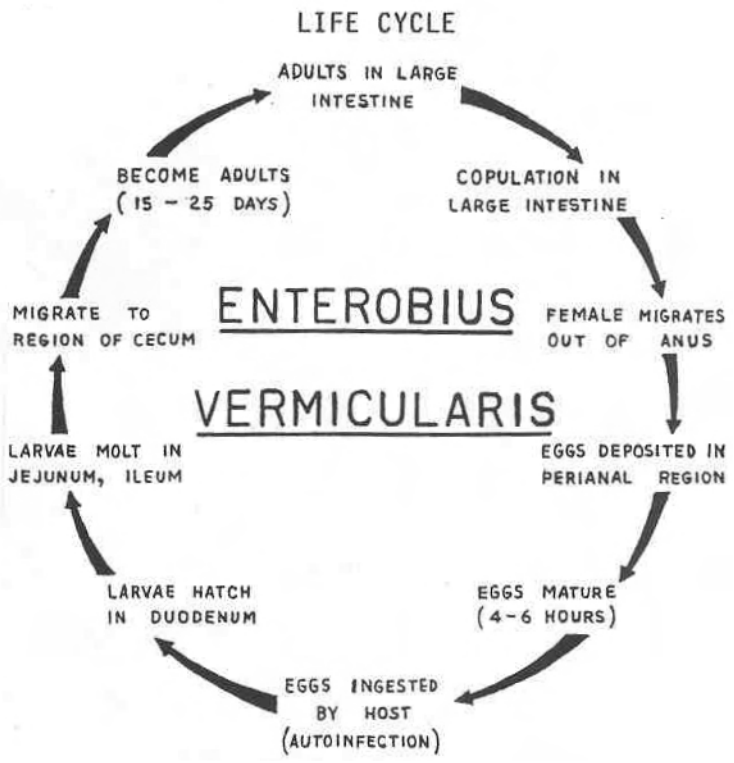
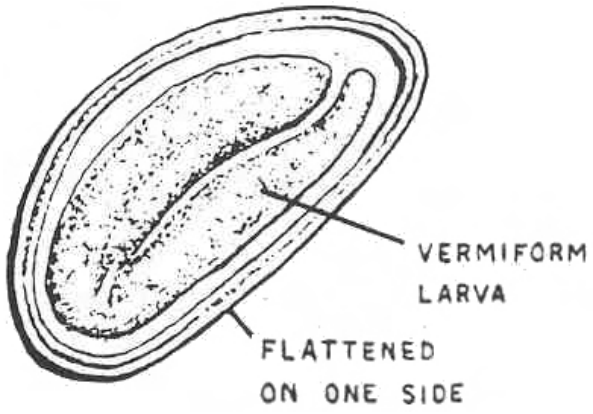

LIFE CYCLE
ADULTS IN LARGE INTESTINE
COPULATION IN LARGE INTESTINE
FEMALE MIGRATES OUT OF ANUS
EGGS DEPOSITED IN PERIANAL REGION
EGGS MATURE (4-6 HOURS)
EGGS INGESTED BY HOST (AUTOINFECTION)
LARVAE HATCH IN DUODENUM
LARVAE MOLT IN JEJUNUM, ILEUM
MIGRATE TO REGION OF CECUM
BECOME ADULTS (15 - 25 DAYS)
ENTEROBIUS VERMICULARIS

Figure 4-7. Life cycle of Enterobius Vermicularis.

### OVA

SIZE: 25 x 55 mcm.
SHAPE: "D" shape (oval); one flattened side.
COLOR: Hyaline.
OPERCULUM: Absent.
CONTENT: First stage vermiform larva, may contain undeveloped larva known as tadpole larva.
SHELL WALL: Triple layer.

## Enterobius vermicularis (Cont'd)




**ADULT**

SIZE
MALE: 2 to 5 mm.
FEMALE: 8 to 13 mm.
SHAPE: Sharply pointed tail in the female.
COLOR: White.
CEPHALIC ALAE: Wing-like structures.
ESOPHAGEAL BULB: Prominent.

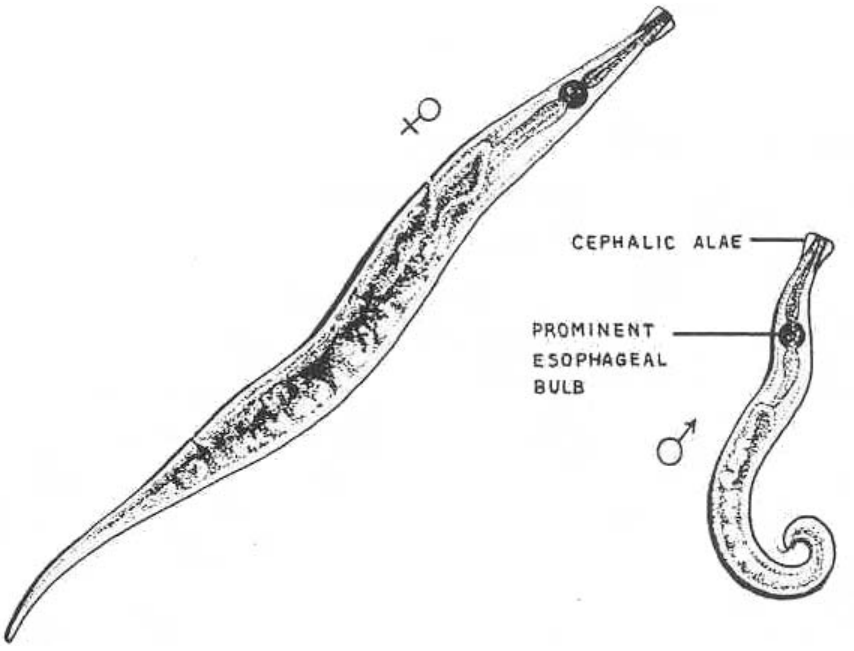



Figure 4-8. Stages of Enterobuis vermicularis.

## ORGANISM 4 Trichostrongylus species

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Inflammation of the intestinal mucosa and gallbladder in heavy infections; secondary anemia, transient eosinophilia; usually asymptomatic.
HABITAT: Small intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Dependant on the species.
INFECTIVE FORM: Semi-filariform larva.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Feces.

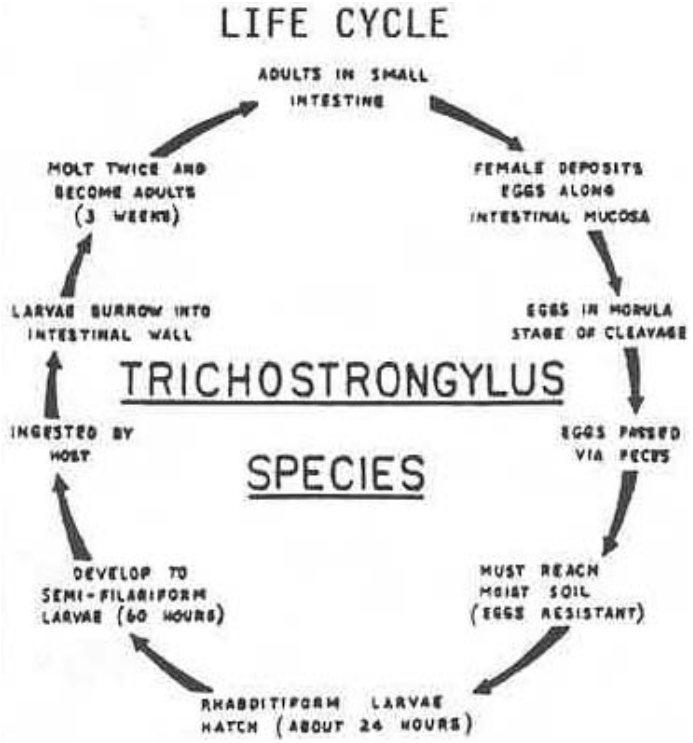
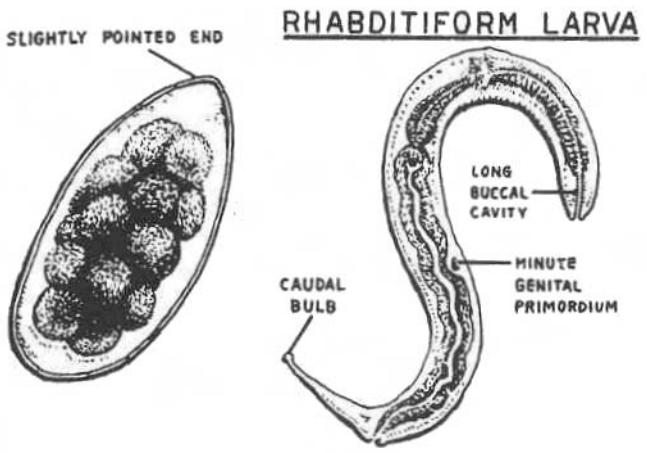

LIFE CYCLE
ADULTS IN SMALL INTESTINE
FEMALE DEPOSITS EGGS ALONG INTESTINAL MUCOSA
EGGS IN MORULA STAGE OF CLEAVAGE
EGGS PASSED VIA FECES
MUST REACH MOIST SOIL (EGGS RESISTANT)
RHABDITIFORM LARVAE HATCH (ABOUT 24 HOURS)
DEVELOP TO SEMI-FILARIFORM LARVAE (60 HOURS)
INGESTED BY HOST
LARVAE BURROW INTO INTESTINAL WALL
MOLT TWICE AND BECOME ADULTS (3 WEEKS)
TRICHOSTRONGYLUS
SPECIES

Figure 4-9. Life cycle of Trichostrongylus species.

### OVA

SIZE: 40 x 90 mcm.
SHAPE: Ellipsoidal, slightly pointed ends.
COLOR: Hyaline.
OPERCULUM: Absent.
CONTENT: Yolk mass.
SHELL WALL: Thin, double.

## Trichostrongylus species (Continued)




**ADULT**

SIZE
MALE: 4 to 6 mm.
FEMALE: 5 to 8 mm.
SHAPE: Round and slender.
COLOR: Colorless.
BUCCAL STRUCTURES: Minute.
COPULATORY BURSA: Present.

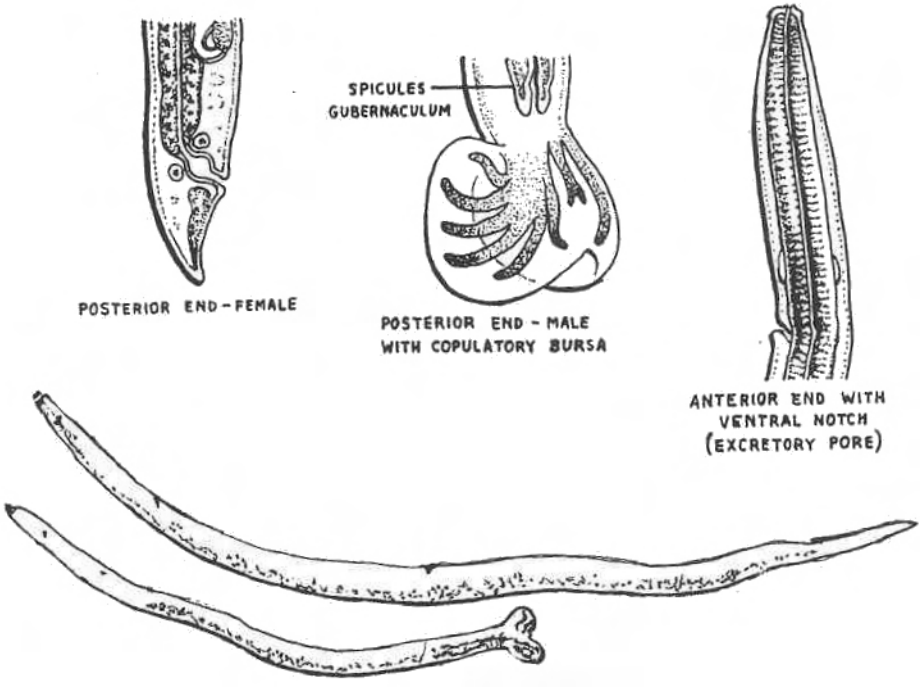

SPICULES
GUBERNACULUM
POSTERIOR END - FEMALE
POSTERIOR END - MALE WITH COPULATORY BURSA
ANTERIOR END WITH VENTRAL NOTCH (EXCRETORY PORE)

Figure 4-10. Stages of Trichostrongylus species.

## ORGANISM 5 Capillaria philippinensis

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Philippines, Thailand.
PATHOGENESIS: Persistent diarrhea, acute intestinal inflammation, malabsorption; tissue destruction; cardiac abnormalities.
HABITAT: Small intestines.
INTERMEDIATE HOST: Fish, none.
RESERVOIR HOST: Rodents.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Ingestion, autoinfective.
SPECIMEN OF CHOICE: Feces.

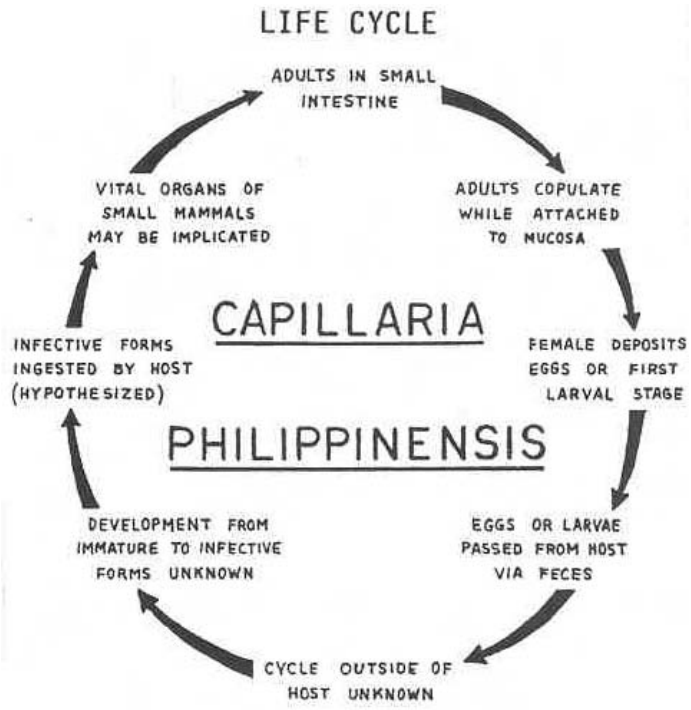
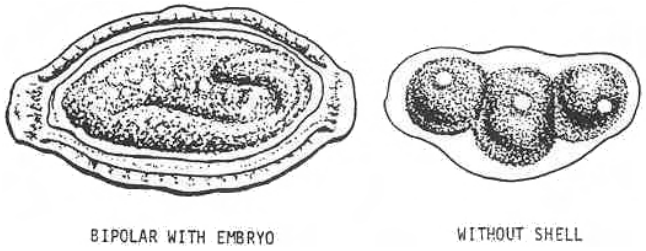

LIFE CYCLE
ADULTS IN SMALL INTESTINE
ADULTS COPULATE WHILE ATTACHED TO MUCOSA
FEMALE DEPOSITS EGGS OR FIRST LARVAL STAGE
EGGS OR LARVAE PASSED FROM HOST VIA FECES
CYCLE OUTSIDE OF HOST UNKNOWN
DEVELOPMENT FROM IMMATURE TO INFECTIVE FORMS UNKNOWN
INFECTIVE FORMS INGESTED BY HOST (HYPOTHESIZED)
VITAL ORGANS OF SMALL MAMMALS MAY BE IMPLICATED
CAPILLARIA
PHILIPPINENSIS

Figure 4-11. Life cycle of Capillaria philippinesis.

### OVA

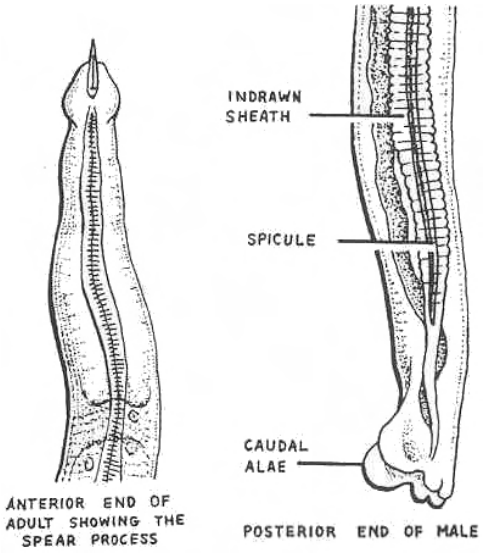
SIZE: 20 x 45 mcm.
SHAPE: Ovoid, irregular shape.
COLOR: Hyaline.
OPERCULUM: Absent.
CONTENT: Yolk mass, developing embryo, larva.
SHELL WALL: If present, thick or thin; with shallow pits.
BIPOLAR PLUGS: Flattened.

## Capillaria philippinensis (continued)




### ADULT

SIZE
MALE: About 2.5 mm.
FEMALE: About 3.5 mm.
SHAPE: Slender and round.
COLOR: Light yellow.




### FREE LARVA

Bluntly rounded at both ends. Conspicuous genital primordium.

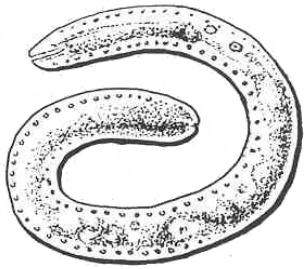


Figure 4-12. Stages of Capillaria philippinensis.

## ORGANISM 6: Ancylostoma duodenale

### GENERAL CHARACTERISTICS

COMMON NAME: Old world hookworm (archaic).
GEOGRAPHICAL DISTRIBUTION: Europe, Asia; becoming worldwide.
PATHOGENESIS: Lesions of intestinal mucosa, anemia (chronic nutritional deficiency type), eosinophilia, pneumonitis, erythemia, dyspnea.
HABITAT: Small intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Hogs, dogs, cats, lions, tigers, and gorillas.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Penetration of the skin.
SPECIMEN OF CHOICE: Feces.

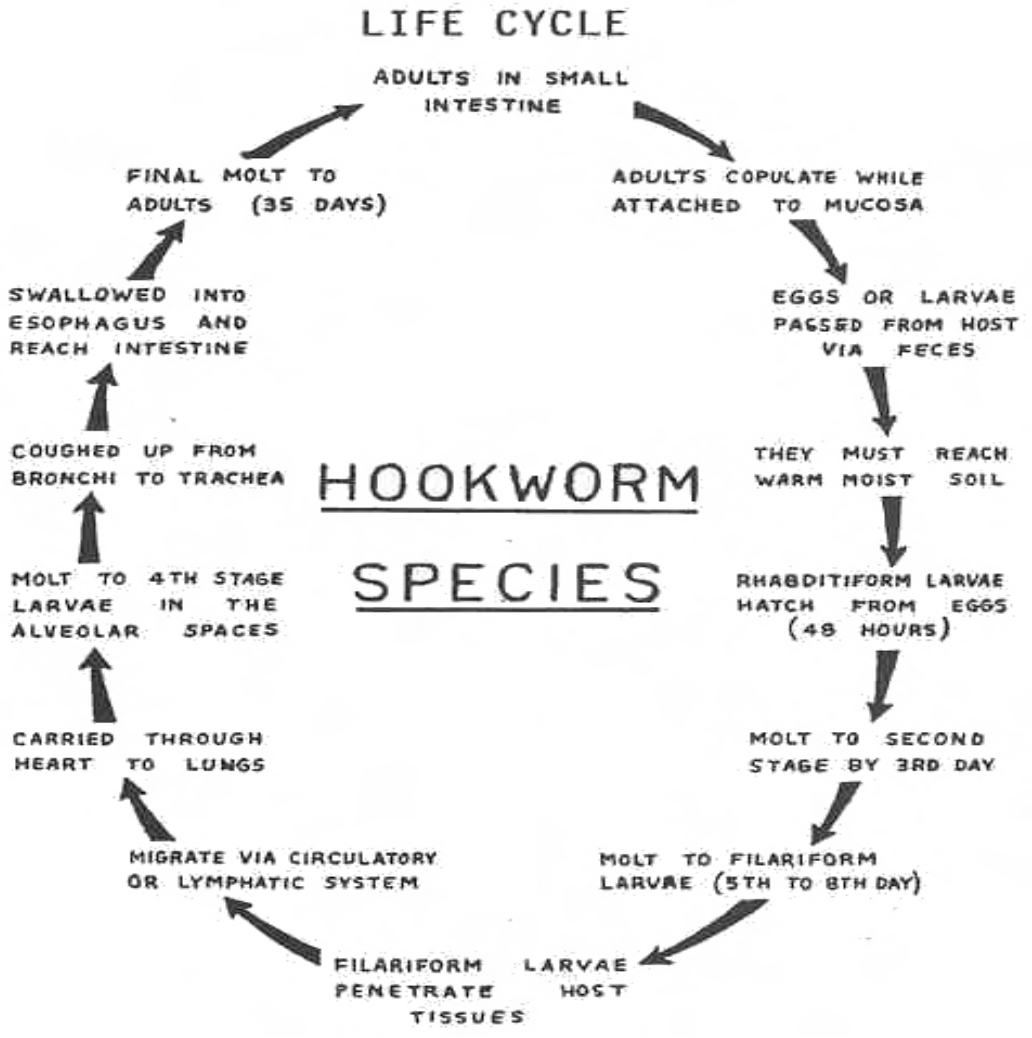
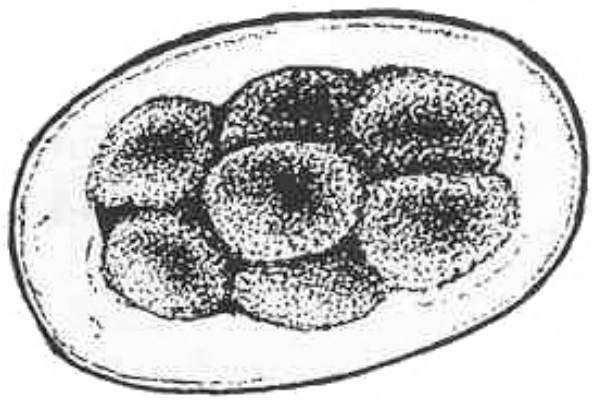

LIFE CYCLE
ADULTS IN SMALL INTESTINE
ADULTS COPULATE WHILE ATTACHED TO MUCOSA
EGGS OR LARVAE PASSED FROM HOST VIA FECES
THEY MUST REACH WARM MOIST SOIL
RHABDITIFORM LARVAE HATCH FROM EGGS (48 HOURS)
MOLT TO SECOND STAGE BY 3RD DAY
MOLT TO FILARIFORM LARVAE (5TH TO 8TH DAY)
FILARIFORM LARVAE PENETRATE HOST TISSUES
MIGRATE VIA CIRCULATORY OR LYMPHATIC SYSTEM
CARRIED THROUGH HEART TO LUNGS
MOLT TO 4TH STAGE LARVAE IN THE ALVEOLAR SPACES
COUGHED UP FROM BRONCHI TO TRACHEA
SWALLOWED INTO ESOPHAGUS AND REACH INTESTINE
FINAL MOLT TO ADULTS (35 DAYS)
HOOKWORM SPECIES

Figure 4-13. Life cycle of Ancylostoma duodenale.

## <u>Ancylostoma duodenale</u> (Continued)

### OVA

SIZE: 40 by 60 mcm.
SHAPE: Oval with bluntly rounded ends.
COLOR: Hyaline.
OPERCULUM: Absent.
CONTENT: Yolk mass usually in cleavage (larva).
SHELL WALL: Thin, single layer.



### ADULT

SIZE
MALE: 8 to 11 mm.
FEMALE: 10 to 13 mm.
SHAPE: Cylindrical; head is curved dorsally.
COLOR: Grayish-white.
BUCCAL STRUCTURES: Two prominent pairs of teeth.
COPULATORY BURSA: Male.
PAIRED COPULATORY SPICULES: Separated.
SMALL PAIRED DORSAL RAYS: Tripartite.

## Ancylostoma duodenale (Continued)

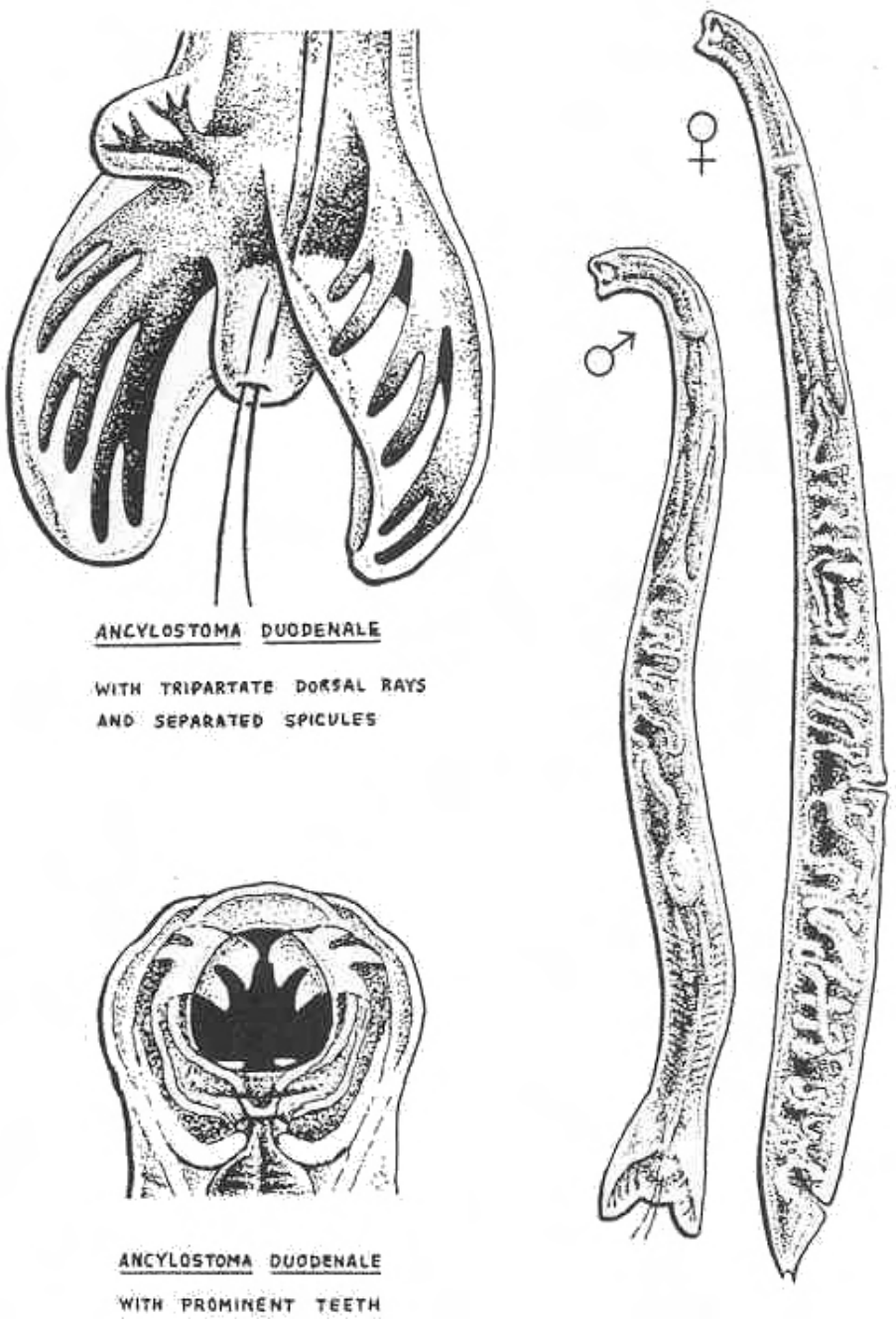



Figure 4-14. Stages of Ancylostoma duodenale.

### RHABDITIFORM LARVA

Same as Necator americanus.

## ORGANISM 7: Necator americanus

### GENERAL CHARACTERISTICS

COMMON NAME: New World hookworm (archaic).
GEOGRAPHICAL DISTRIBUTION: Western hemisphere.
PATHOGENESIS: Inflammation of intestinal mucosa, anemia (chronic nutritional deficiency type) diarrhea, pneumonitis, eosinophilia, erythemia, dyspnea. Same as A. duodenale.
HABITAT: Small intestines.
INTERMEDIATE HOST: None.
RESERVOIR HOST: None.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Active penetration.
SPECIMEN OF CHOICE: Feces.

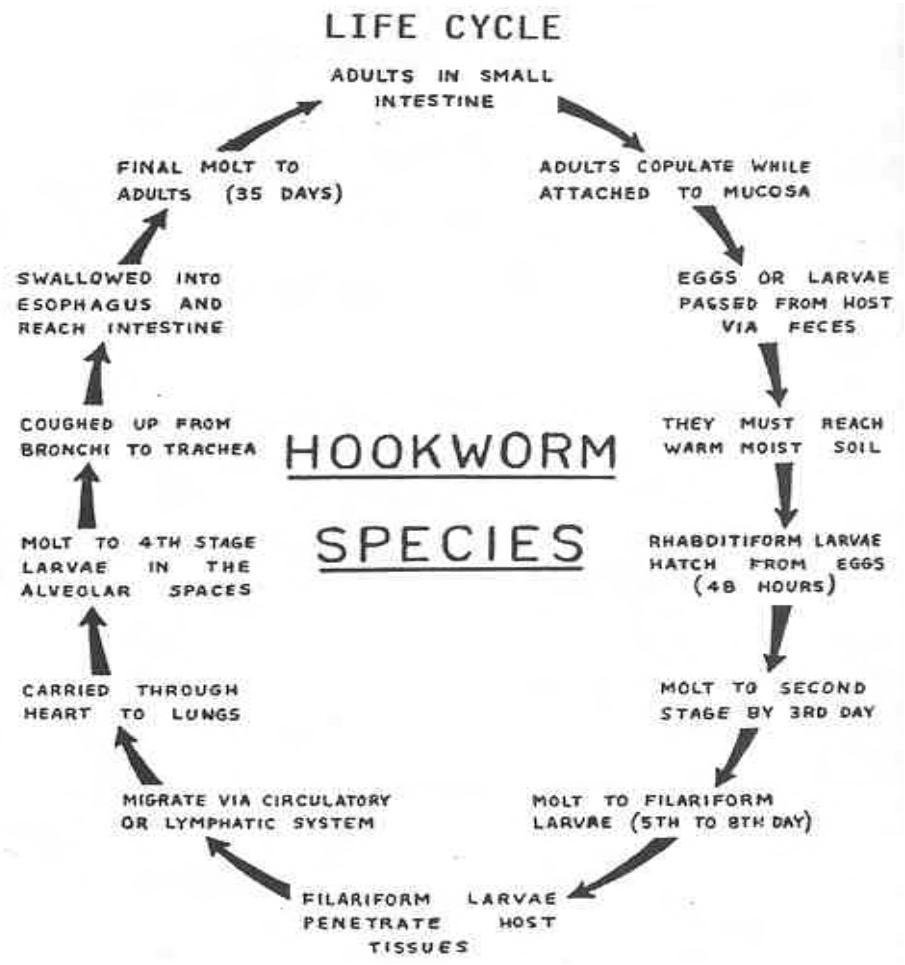

LIFE CYCLE
ADULTS IN SMALL INTESTINE
ADULTS COPULATE WHILE ATTACHED TO MUCOSA
EGGS OR LARVAE PASSED FROM HOST VIA FECES
THEY MUST REACH WARM MOIST SOIL
RHABDITIFORM LARVAE HATCH FROM EGGS (48 HOURS)
MOLT TO SECOND STAGE BY 3RD DAY
MOLT TO FILARIFORM LARVAE (5TH TO 8TH DAY)
FILARIFORM LARVAE PENETRATE HOST TISSUES
MIGRATE VIA CIRCULATORY OR LYMPHATIC SYSTEM
CARRIED THROUGH HEART TO LUNGS
MOLT TO 4TH STAGE LARVAE IN THE ALVEOLAR SPACES
COUGHED UP FROM BRONCHI TO TRACHEA
SWALLOWED INTO ESOPHAGUS AND REACH INTESTINE
FINAL MOLT TO ADULTS (35 DAYS)
HOOKWORM SPECIES

Figure 4-15. Life cycle of Necator americanus.

## Necator americanus (continued)

### OVA

Same as A. duodenale

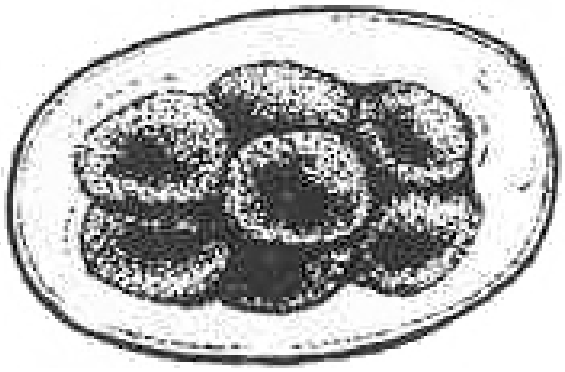
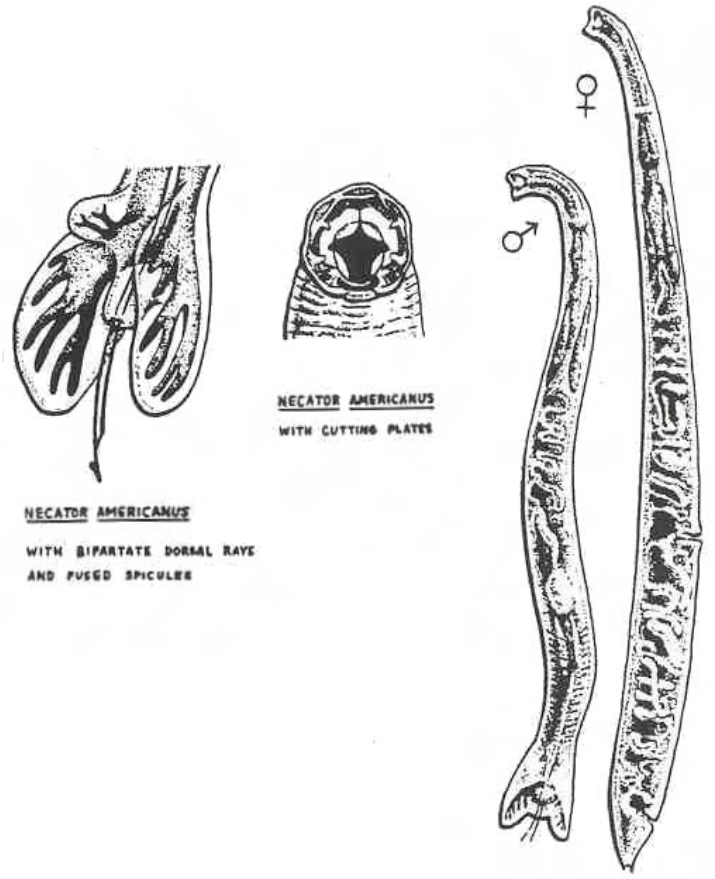


Figure 4-16. Stages of Necator americanus. Continued)

### ADULT

SIZE: Smaller than A. duodenale.
Male: 5 to 9 mm.
FEMALE: 9 to 11 mm.
SHAPE: Cylindrical; head is sharply dorsally curved.
COLOR: Grayish-white.
BUCCAL STRUCTURES: Prominent ventral and dorsal semilunar cutting plates.
COPULATORY BURSA: Male.
PAIRED COPULATORY SPICULES: Fused with a terminal barb.
SMALL PAIRED DORSAL RAYS: Bipartite.




**RHABDITIFORM LARVAE**

SIZE: 250 mcm.
BUCCAL CAVITY: large (longitudinal parallel lines).
GENITAL PRIMORDIUM: Small (inconspicuous).
TAIL: Slender, long, and tapering.

Figure 4-16. Stages of Necator americanus. Continued)

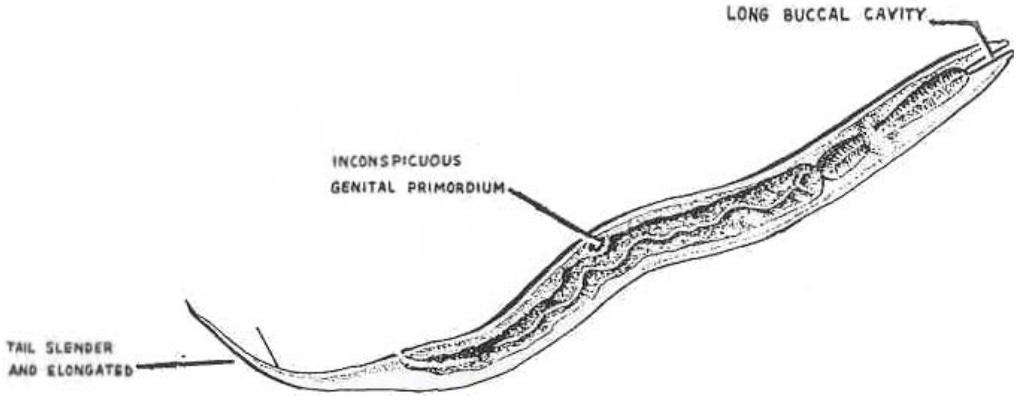



Figure 4-16. Stages of Necator americanus. (concluded)

## ORGANISM 8: Strongyloides stercoralis

### GENERAL CHARACTERISTICS

COMMON NAME: Threadworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Chronic gastrointestinal inflammation, eosinophilia, anemia, recurrent diarrhea, secondary bacterial infections, biliary and pancreatic inflammation.
HABITAT: Small intestine.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Perhaps dogs and apes.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Active penetration.
SPECIMEN OF CHOICE: Feces.

## Strongyloides stercoralis (continued)

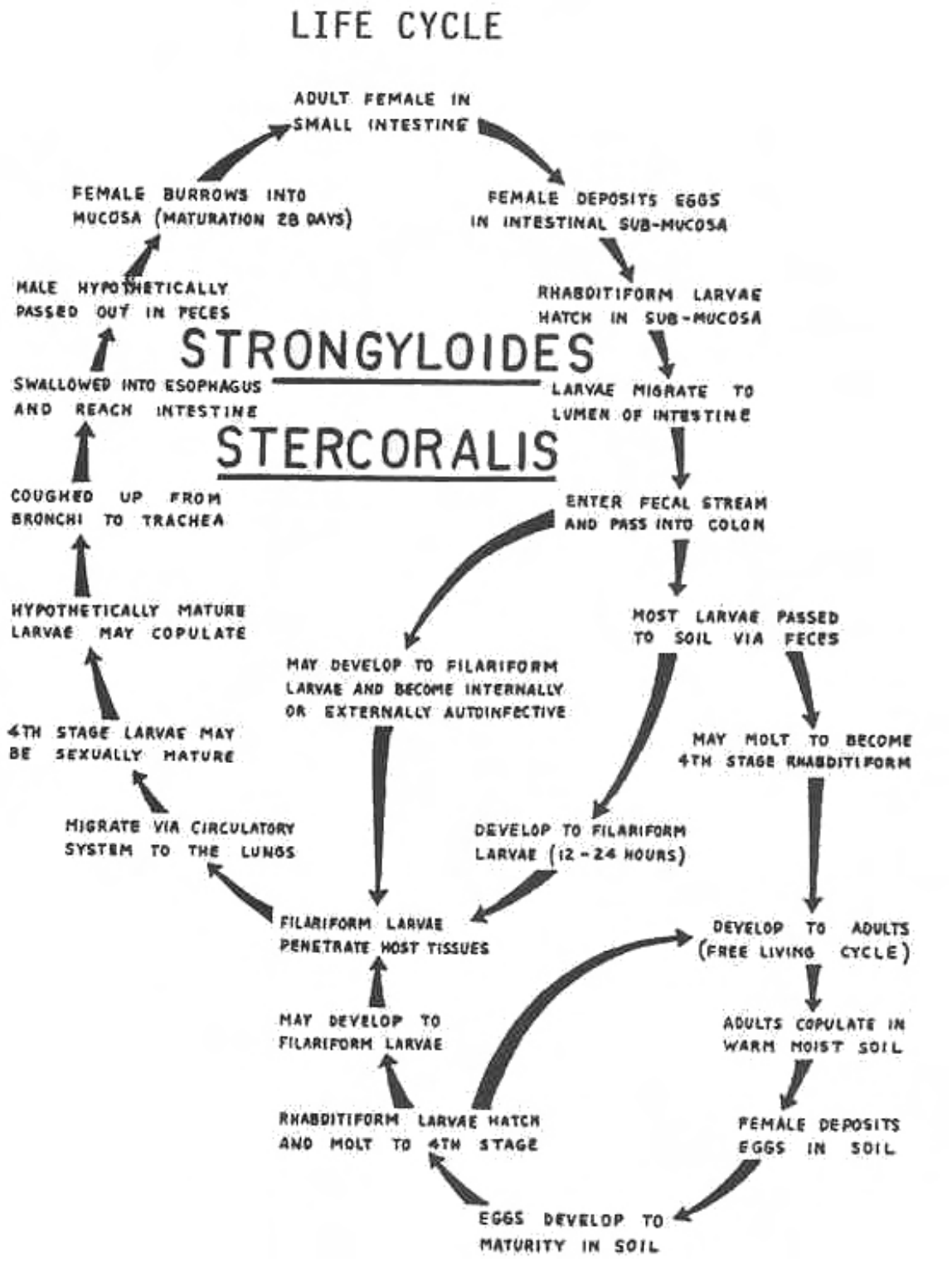

LIFE CYCLE
STRONGYLOIDES
STERCORALIS
ADULT FEMALE IN SMALL INTESTINE
FEMALE DEPOSITS EGGS IN INTESTINAL SUB-MUCOSA
RHABDITIFORM LARVAE HATCH IN SUB-MUCOSA
LARVAE MIGRATE TO LUMEN OF INTESTINE
ENTER FECAL STREAM AND PASS INTO COLON
MOST LARVAE PASSED TO SOIL VIA FECES
MAY MOLT TO BECOME 4TH STAGE RHABDITIFORM
DEVELOP TO ADULTS (FREE LIVING CYCLE)
ADULTS COPULATE IN WARM MOIST SOIL
FEMALE DEPOSITS EGGS IN SOIL
EGGS DEVELOP TO MATURITY IN SOIL
RHABDITIFORM LARVAE HATCH AND MOLT TO 4TH STAGE
MAY DEVELOP TO FILARIFORM LARVAE
FILARIFORM LARVAE PENETRATE HOST TISSUES
MAY DEVELOP TO FILARIFORM LARVAE AND BECOME INTERNALLY OR EXTERNALLY AUTOINFECTIVE
DEVELOP TO FILARIFORM LARVAE (12-24 HOURS)
MIGRATE VIA CIRCULATORY SYSTEM TO THE LUNGS
4TH STAGE LARVAE MAY BE SEXUALLY MATURE
HYPOTHETICALLY MATURE LARVAE MAY COPULATE
COUGHED UP FROM BRONCHI TO TRACHEA
SWALLOWED INTO ESOPHAGUS AND REACH INTESTINE
MALE HYPOTHETICALLY PASSED OUT IN FECES
FEMALE BURROWS INTO MUCOSA (MATURATION 28 DAYS)

Figure 4-17. Life cycle of Strongyloides stercoralis. Parasitic and Free Living Cycles

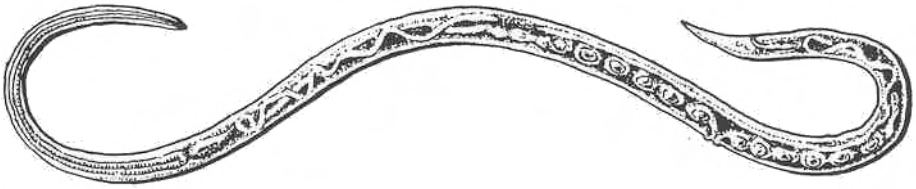
## Strongyloides stercoralis (continued)

### OVA

Rarely seen; similar to Hookworm species eggs; may contain a larva.

### ADULT

SIZE
MALE: Less than 1 mm; seen only in free living cycle.
FEMALE: 1 mm for the free living; 2 mm for the parasitic.
SHAPE: Very slender, threadlike, male has a curved tail.
COLOR: Colorless; semitransparent.
BUCCAL STRUCTURES: Short buccal cavity.
COPULATORY BURSA: Absent.
SPICULES: Two.



### RHABDITIFORM LARVA

SIZE: 250 mcm.
BUCCAL CAVITY: Short.
GENITAL PRIMORDIUM: Large and conspicuous.
TAIL: Short and stubby.

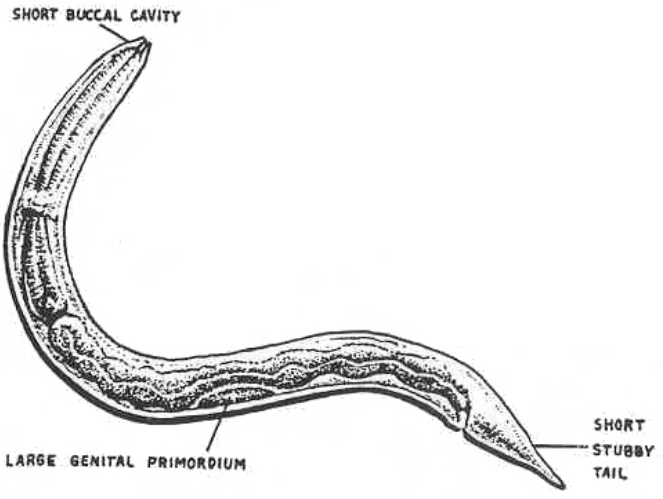



Figure 4-18. Stages of Strongyloides stercoralis.

B. **Tissue Dwelling Nematodes**

## ORGANISM 1: Toxocara species (T. canis and T. cati)

### GENERAL CHARACTERISTICS

COMMON NAME: Visceral larval.
GEOGRAPHICAL DISTRIBUTION: Worldwide migrans.
PATHOGENESIS: Granulomatous lesions of liver, lungs and other organs, eosinophilia, anemia, hepatosplenomegaly, pneumonitis, dermatitis, neurologicaldisturbances, tumors of eyes, spinal cord and heart in severe cases.
HABITAT
MAN: Any organs and tissues of the body.
DEFINITIVE HOST: Small intestines of dogs and cats.
INTERMEDIATE HOST: None.
RESERVOIR HOST: Same as definitive host, dogs and cats.
INFECTIVE FORM: Embryonated egg.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Tissue biopsy and serological.

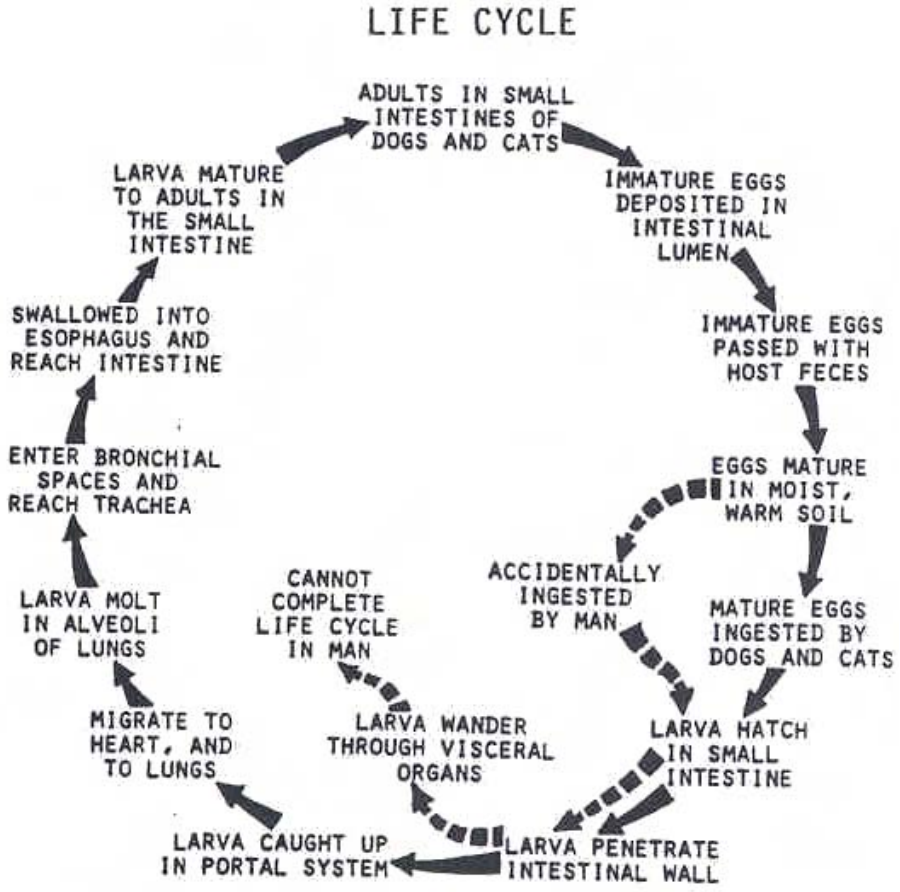

LIFE CYCLE
ADULTS IN SMALL INTESTINES OF DOGS AND CATS
IMMATURE EGGS DEPOSITED IN INTESTINAL LUMEN
IMMATURE EGGS PASSED WITH HOST FECES
EGGS MATURE IN MOIST, WARM SOIL
MATURE EGGS INGESTED BY DOGS AND CATS
ACCIDENTALLY INGESTED BY MAN
CANNOT COMPLETE LIFE CYCLE IN MAN
LARVA HATCH IN SMALL INTESTINE
LARVA WANDER THROUGH VISCERAL ORGANS
LARVA PENETRATE INTESTINAL WALL
LARVA CAUGHT UP IN PORTAL SYSTEM
MIGRATE TO HEART, AND TO LUNGS
LARVA MOLT IN ALVEOLI OF LUNGS
ENTER BRONCHIAL SPACES AND REACH TRACHEA
SWALLOWED INTO ESOPHAGUS AND REACH INTESTINE
LARVA MATURE TO ADULTS IN THE SMALL INTESTINE

Figure 4-19. Life cycle of Toxocara species.

## Toxocara species (continued)

### OVA

Seen in feces of infected pets.
SIZE: 85 by 75 mcm.
SHAPE: Spherical.
COLOR: Light brown.
OPERCULUM: Absent.
CONTENT: Developing larva (yolk mass)

### ADULT

Seen in definitive host.
SIZE
MALE: 4 to 6 cm.
FEMALE: 6.5 to 10 cm.
SHAPE: Elongated, cylindrical.
COLOR: Pinkish-white.
BUCCAL STRUCTURES: Three characteristic lips.
CERVICAL ALAE

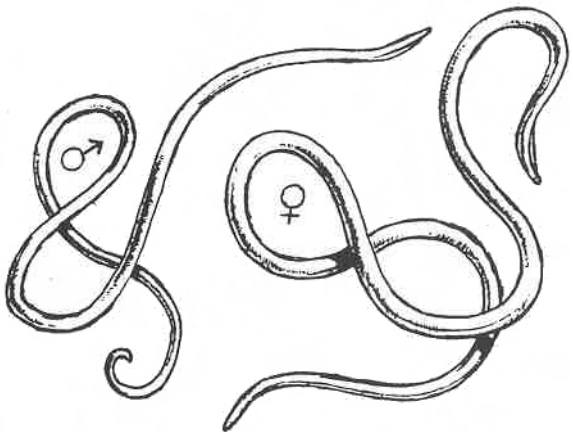



Figure 4-20. Stages of Toxocara species. (continued)

## Toxocara species (continued)

### LARVA

Seen in tissues of man: larval section surrounded by granuloma.

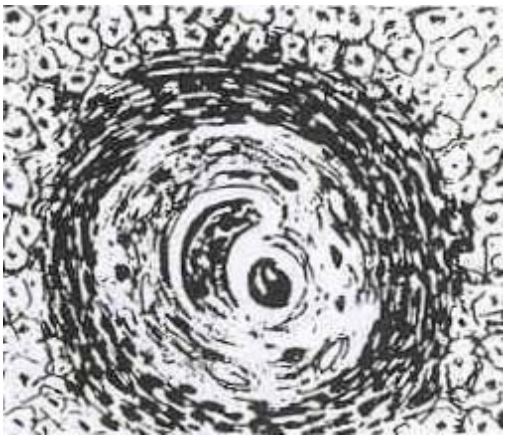


Figure 4-20. Stages of Toxocara species. (concluded)

## ORGANISM 2: Ancylostoma species

### GENERAL CHARACTERISTICS

COMMON NAME: Cutaneous larva migrans, creeping eruption.
GEOGRAPHICAL DISTRIBUTION: Worldwide; tropics and subtropics.
PATHOGENESIS: Eosinophilia, cellular infiltration, reddish serpiginous intracutaneous tunnels, secondary bacterial infections.
HABITAT
MAN: Cutaneous and subcutaneous tissue.
DEFINITIVE HOST: Small intestines (usually cats and dogs).
INTERMEDIATE HOST: None.
RESERVOIR HOST: Same as the definitive host.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Penetration.
SPECIMEN OF CHOICE: Clinical evidence is diagnostic.

## Ancylostoma species (continued)

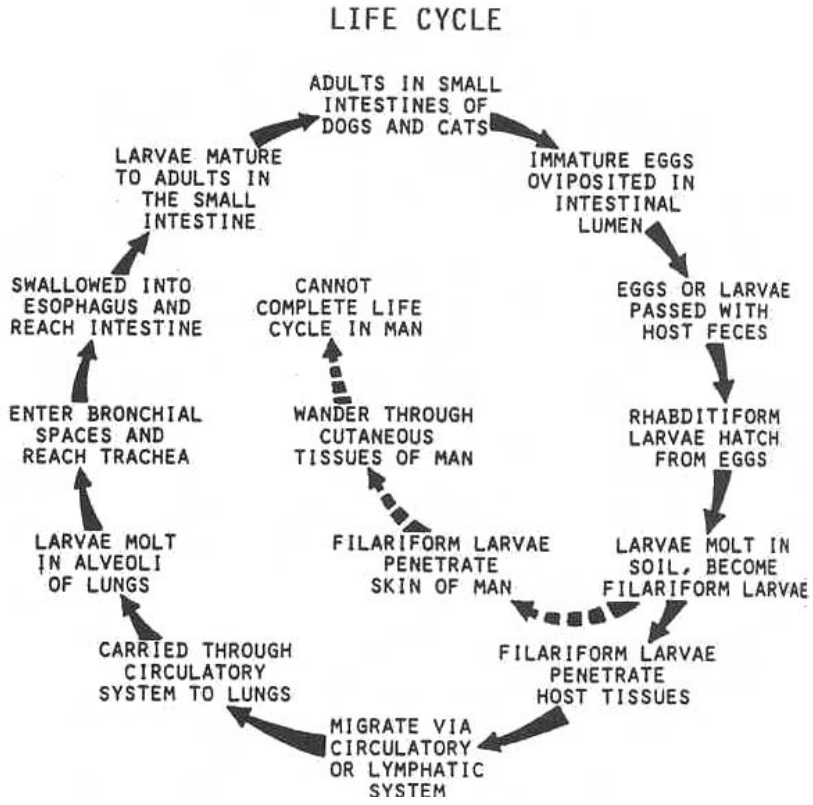

LIFE CYCLE
ADULTS IN SMALL INTESTINES OF DOGS AND CATS
IMMATURE EGGS OVIPOSITED IN INTESTINAL LUMEN
EGGS OR LARVAE PASSED WITH HOST FECES
RHABDITIFORM LARVAE HATCH FROM EGGS
LARVAE MOLT IN SOIL, BECOME FILARIFORM LARVAE
FILARIFORM LARVAE PENETRATE HOST TISSUES
MIGRATE VIA CIRCULATORY OR LYMPHATIC SYSTEM
CARRIED THROUGH CIRCULATORY SYSTEM TO LUNGS
LARVAE MOLT IN ALVEOLI OF LUNGS
ENTER BRONCHIAL SPACES AND REACH TRACHEA
SWALLOWED INTO ESOPHAGUS AND REACH INTESTINE
LARVAE MATURE TO ADULTS IN THE SMALL INTESTINE
FILARIFORM LARVAE PENETRATE SKIN OF MAN
WANDER THROUGH CUTANEOUS TISSUES OF MAN
CANNOT COMPLETE LIFE CYCLE IN MAN

Figure 4-21. Life cycle of Ancylostoma species.

### OVA AND LARVAE

Seen in feces of infected dogs; Indistinguishable from human hookworm species

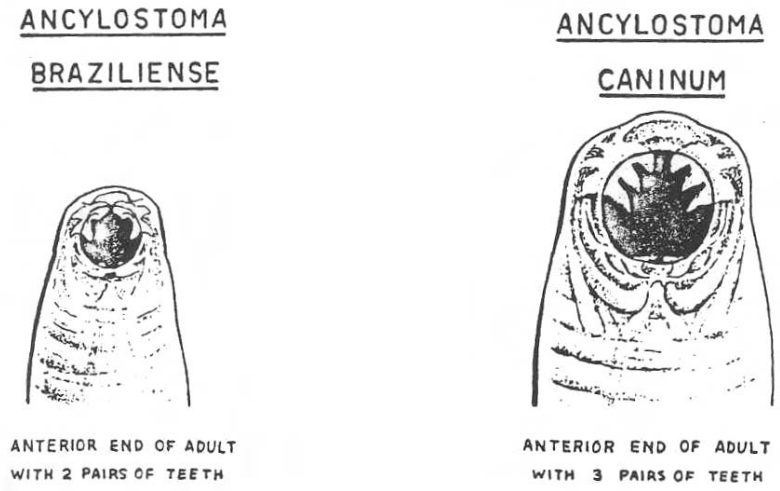

ANCYLOSTOMA BRAZILIENSE
ANTERIOR END OF ADULT WITH 2 PAIRS OF TEETH
ANCYLOSTOMA CANINUM
ANTERIOR END OF ADULT WITH 3 PAIRS OF TEETH

Figure 4-22. Ancylostoma species.

## ORGANISM 3: Capillaria hepatica

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Worldwide.
PATHOGENESIS: Inflammation of the liver, tissue destruction, cardiac abnormalities.
HABITAT: Liver.
TRANSPORT HOST: Same species as definitive host, carnivores.
RESERVOIR HOST: Mice, rats, prairie dogs, beavers, monkeys.
INFECTIVE FORM: Embryonated eggs.
MODE OF INFECTION: Ingestion of contaminated soil or food
SPECIMEN OF CHOICE: Liver biopsy.

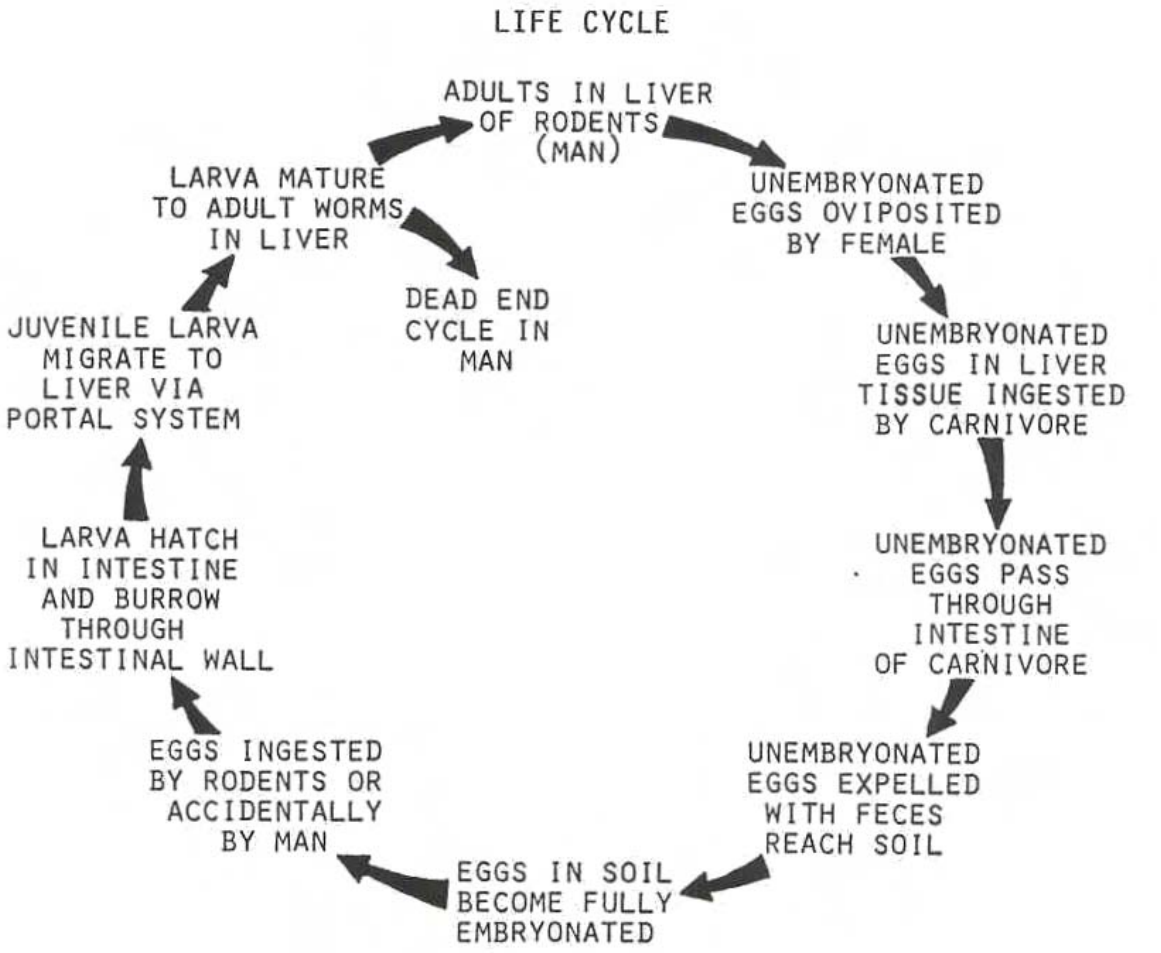
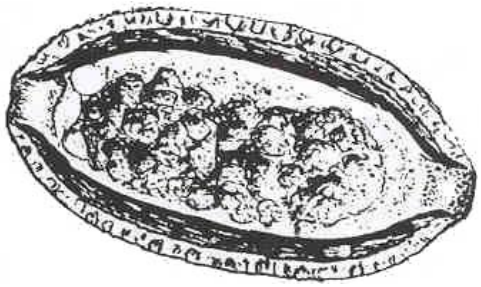

LIFE CYCLE
ADULTS IN LIVER OF RODENTS (MAN)
UNEMBRYONATED EGGS OVIPOSITED BY FEMALE
UNEMBRYONATED EGGS IN LIVER TISSUE INGESTED BY CARNIVORE
UNEMBRYONATED EGGS PASS THROUGH INTESTINE OF CARNIVORE
UNEMBRYONATED EGGS EXPELLED WITH FECES REACH SOIL
EGGS IN SOIL BECOME FULLY EMBRYONATED
EGGS INGESTED BY RODENTS OR ACCIDENTALLY BY MAN
LARVA HATCH IN INTESTINE AND BURROW THROUGH INTESTINAL WALL
JUVENILE LARVA MIGRATE TO LIVER VIA PORTAL SYSTEM
LARVA MATURE TO ADULT WORMS IN LIVER
DEAD END CYCLE IN MAN

Figure 4-23. Life cycle of Capillaria hepatica.

## Capillaria hepatica (continued)

### OVA

SIZE: 30 x 60 mcm.
SHAPE: Barrel-shaped.
COLOR: Brown.
OPERCULUM: Absent.
CONTENT: Yolk mass.
SHELL WALL: Thick and pitted; bipolar plug.



### ADULT

SIZE
- MALE: About 4 mm.
- FEMALE: About 10 mm.

SHAPE: slender and round.
COLOR: Cream-colored.

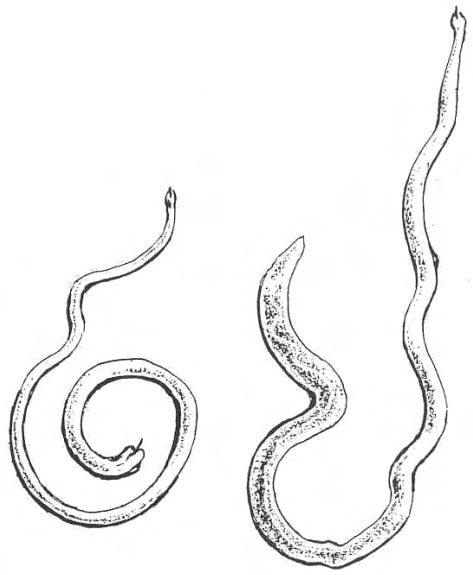


Figure 4-24. Stages of Capillaria hepatica.

## ORGANISM 4: Trichinella spiralis

### GENERAL CHARACTERISTICS

COMMON NAME: Trichina worm.
GEOGRAPHICAL DISTRIBUTION: Worldwide; prevalent in pork eating countries (USA and Europe).
PATHOGENESIS: Larval invasion of striated muscle and vital organs, eosinophilia, acute interstitial inflammation, pneumonitis, pleurisy, encephalitis (periorbital swelling), meningitis, nephritis, deafness, peritonitis, eye and brain trauma, myocarditis.
HABITAT
ADULTS: Small intestines.
LARVAE: Striated muscle.
INTERMEDIATE HOST: Carnivores; pigs. One host may serve as both definitive and intermediate host.
RESERVOIR HOST: Pigs, wild boars, rats, bears, walruses, and many other carnivores.
INFECTIVE FORM: Encysted larvae.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Tissue biopsy.

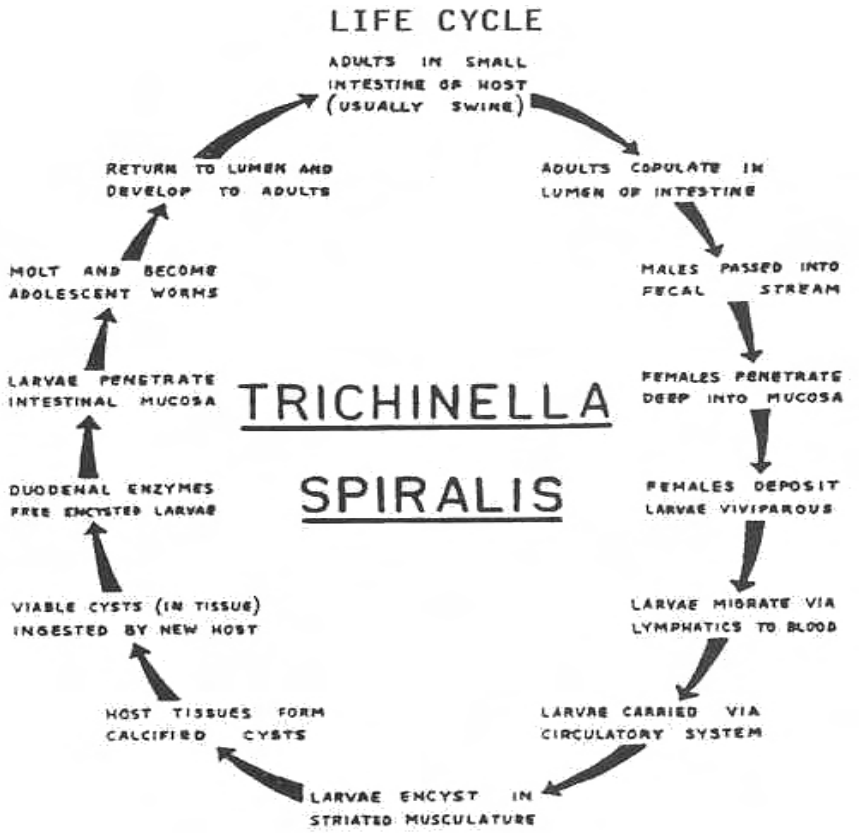
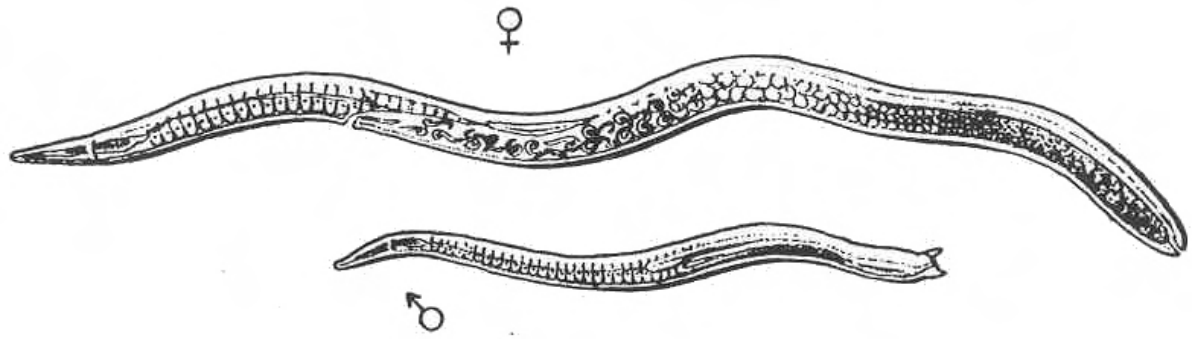

LIFE CYCLE
ADULTS IN SMALL INTESTINE OF HOST (USUALLY SWINE)
ADULTS COPULATE IN LUMEN OF INTESTINE
MALES PASSED INTO FECAL STREAM
FEMALES PENETRATE DEEP INTO MUCOSA
FEMALES DEPOSIT LARVAE VIVIPAROUS
LARVAE MIGRATE VIA LYMPHATICS TO BLOOD
LARVAE CARRIED VIA CIRCULATORY SYSTEM
LARVAE ENCYST IN STRIATED MUSCULATURE
HOST TISSUES FORM CALCIFIED CYSTS
VIABLE CYSTS (IN TISSUE) INGESTED BY NEW HOST
DUODENAL ENZYMES FREE ENCYSTED LARVAE
LARVAE PENETRATE INTESTINAL MUCOSA
MOLT AND BECOME ADOLESCENT WORMS
RETURN TO LUMEN AND DEVELOP TO ADULTS
TRICHINELLA SPIRALIS

Figure 4-25. Life cycle of Trichinella spiralis.

## Trichinella spiralis (continued)

### ADULT

SIZE
MALE: About 1.5 mm .
FEMALE: 3 to 4 mm.
SHAPE: Slender tapering to a large posterior end.
COLOR: Colorless.
MALE: Has two caudal appendages.



### RHABDITIFORM LARVAE

SIZE: 6 x 100 mcm.
SHAPE: Coiled.
COLOR: Colorless.
IN STRIATED MUSCLE: Surrounded by a longitudinal capsule.

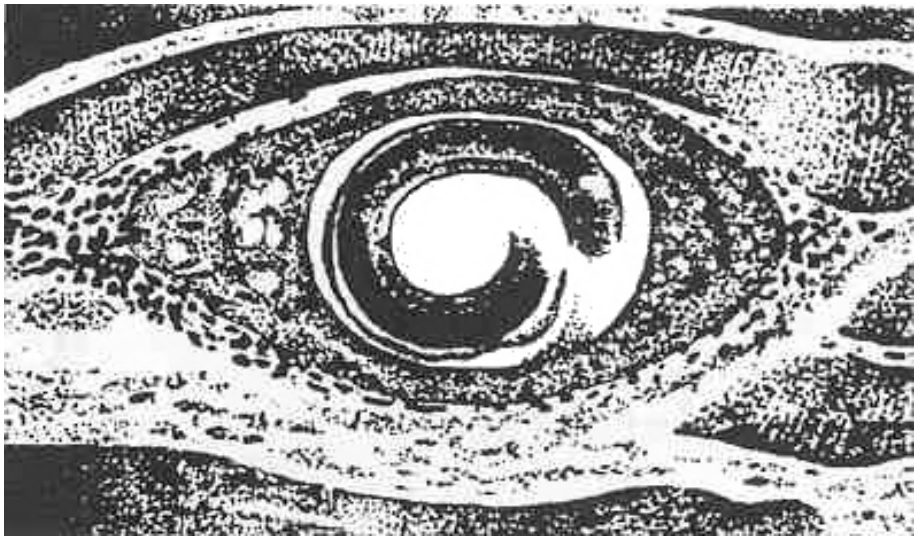


Figure 4-26. Stages of Trichinella spiralis.

## ORGANISM 5: Dracunculus medinensis

### GENERAL CHARACTERISTICS

COMMON NAME: Guinea worm.
GEOGRAPHICAL DISTRIBUTION: Africa, Asia (India).
PATHOGENESIS: Subcutaneous blisters, edema, abscesses, extensive ulceration, necrosis, eosinophilia.
HABITAT: Connective and subcutaneous tissue.
INTERMEDIATE HOST: Copepod (Cyclops species).
RESERVOIR HOST: Dogs, cats, apes, cattle, and horses.
INFECTIVE FORM: Third-stage larva.
MODE OF INFECTION: Ingestion.
SPECIMEN OF CHOICE: Exudate from irrigated lesions.

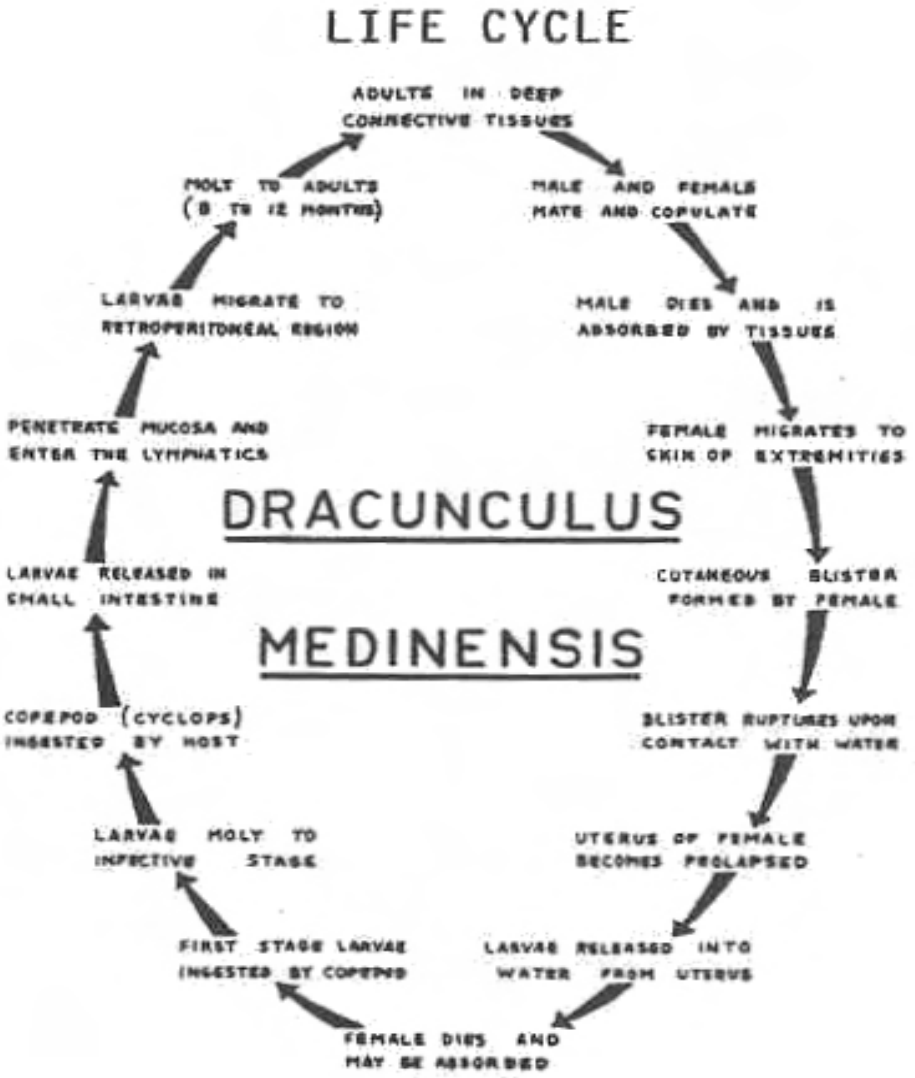
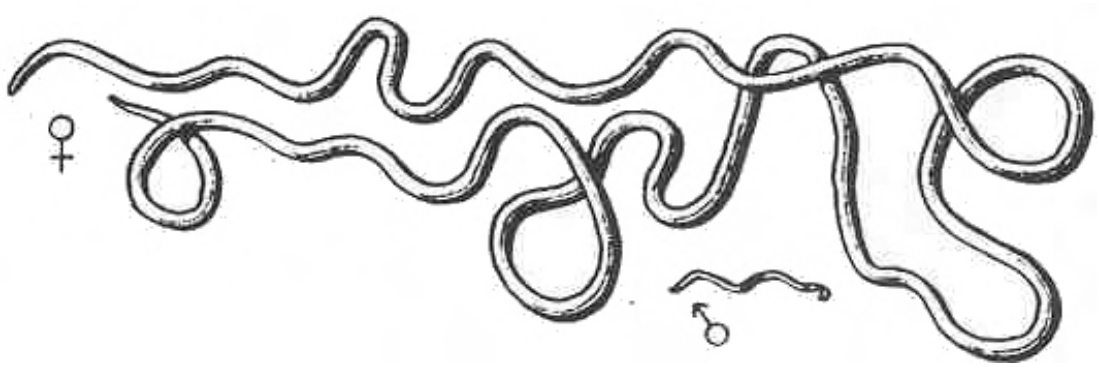

LIFE CYCLE
ADULTS IN DEEP CONNECTIVE TISSUES
MALE AND FEMALE MATE AND COPULATE
MALE DIES AND IS ABSORBED BY TISSUES
FEMALE MIGRATES TO SKIN OF EXTREMITIES
CUTANEOUS BLISTER FORMED BY FEMALE
BLISTER RUPTURES UPON CONTACT WITH WATER
UTERUS OF FEMALE BECOMES PROLAPSED
LARVAE RELEASED INTO WATER FROM UTERUS
FEMALE DIES AND MAY BE ABSORBED
FIRST STAGE LARVAE INGESTED BY COPEPOD
LARVAE MOLT TO INFECTIVE STAGE
COPEPOD (CYCLOPS) INGESTED BY HOST
LARVAE RELEASED IN SMALL INTESTINE
PENETRATE MUCOSA AND ENTER THE LYMPHATICS
LARVAE MIGRATE TO RETROPERITONEAL REGION
MOLT TO ADULTS (8 TO 12 MONTHS)
DRACUNCULUS
MEDINENSIS

Figure 4-27. Life cycle of Dracunculus medinensis.

## Dracunculus medinensis (continued)

### ADULT

SIZE
MALE: Inconspicuous, less than 3 cm.
FEMALE: 75 to 120 cm.
SHAPE: Elongated, cylindrical, rope-like.
COLOR: White.
BUCCAL STRUCTURES: Small triangular mouth surrounded by a quadrangular sclerotized plate.
EXTRACTED from ulcerated lesion.




### RHABDITIFORM LARVAE

SIZE: 500 to 750 mcm.
SHAPE: Slender with a long filariform tail.
COLOR: colorless.
CUTICLE: Striated.

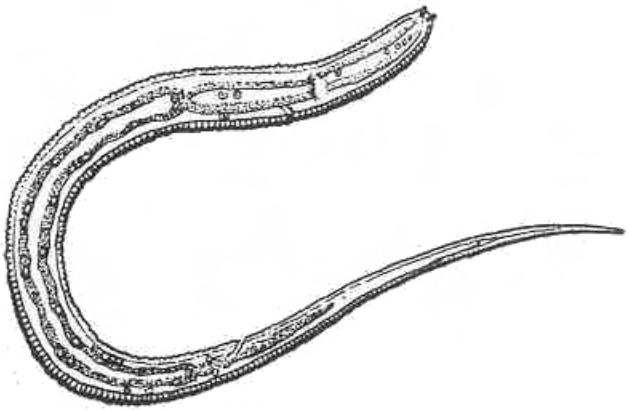


Figure 4-28. Stages of Dracunculus medinensis.

## 4-3. BLOOD AND TISSUE NEMATODES

This family consists of members which have a unique stage in their life cycle called the microfilaria. This stage is equivalent to the rhabditiform larva of other nematodes. This is the stage which is infective to the vectors and, therefore, it must reach either the circulatory or lymphatic system. The microfilariae of some species retain the elongated egg membrane which shows as a characteristic sheath. In other species, the membrane is discarded and these are referred to as being unsheathed.

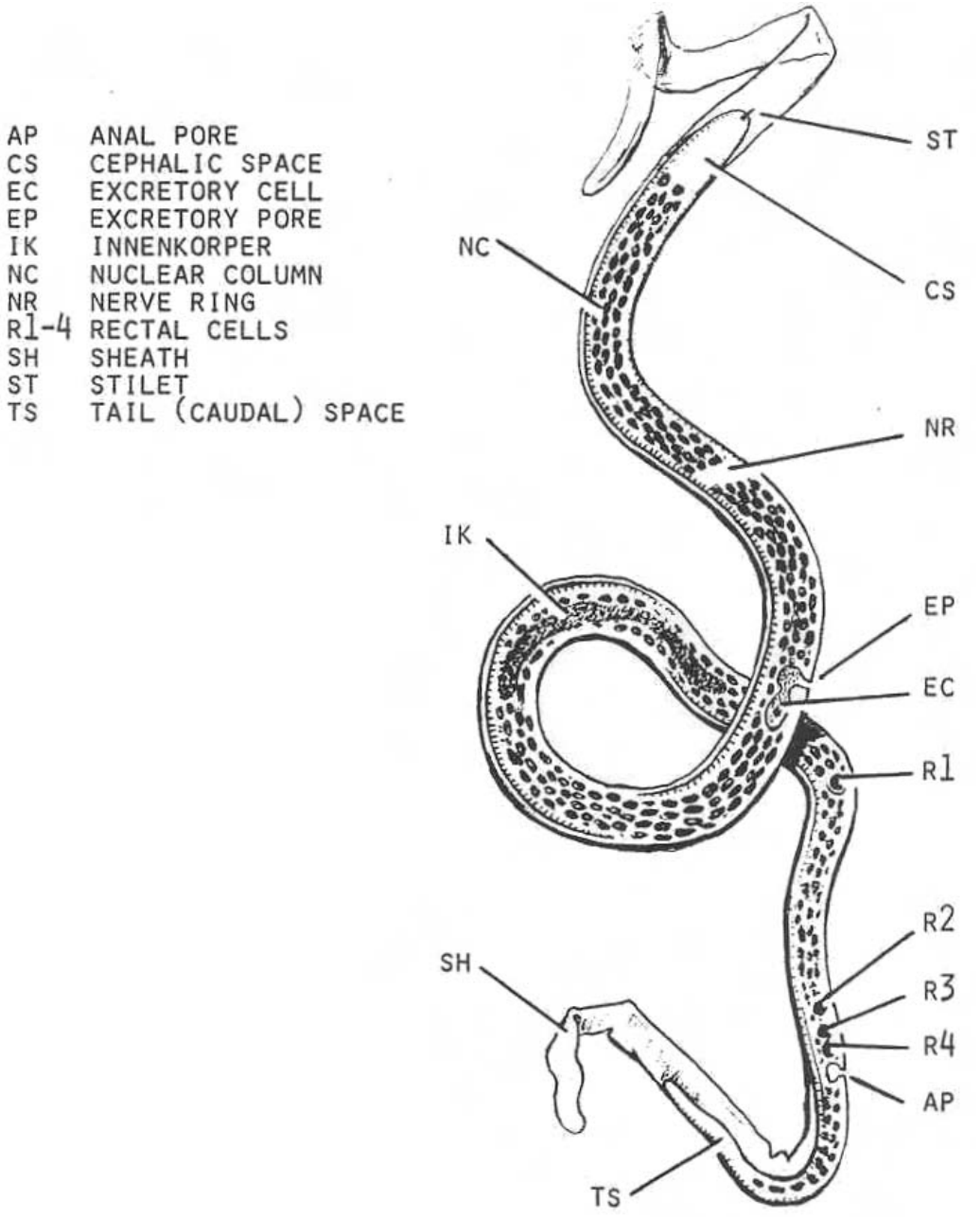



Figure 4-29. Typical microfilaria.

## ORGANISM 1: Wuchereria bancrofti

### GENERAL CHARACTERISTICS

COMMON NAME: Bancroft's filariasis, elephantiasis worm.
GEOGRAPHICAL DISTRIBUTION: Worldwide, prevalent in the tropics and subtropics.
PATHOGENESIS: Elephantiasis, fibrosis, thrombi, lymphatic inflammation, granulomatous infiltration.
HABITAT: Lymphatic system.
VECTOR: Mosquitoes.
RESERVOIR HOST: None.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: Nocturnal with subperiodic Pacific strains.
SPECIMEN OF CHOICE: Blood.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

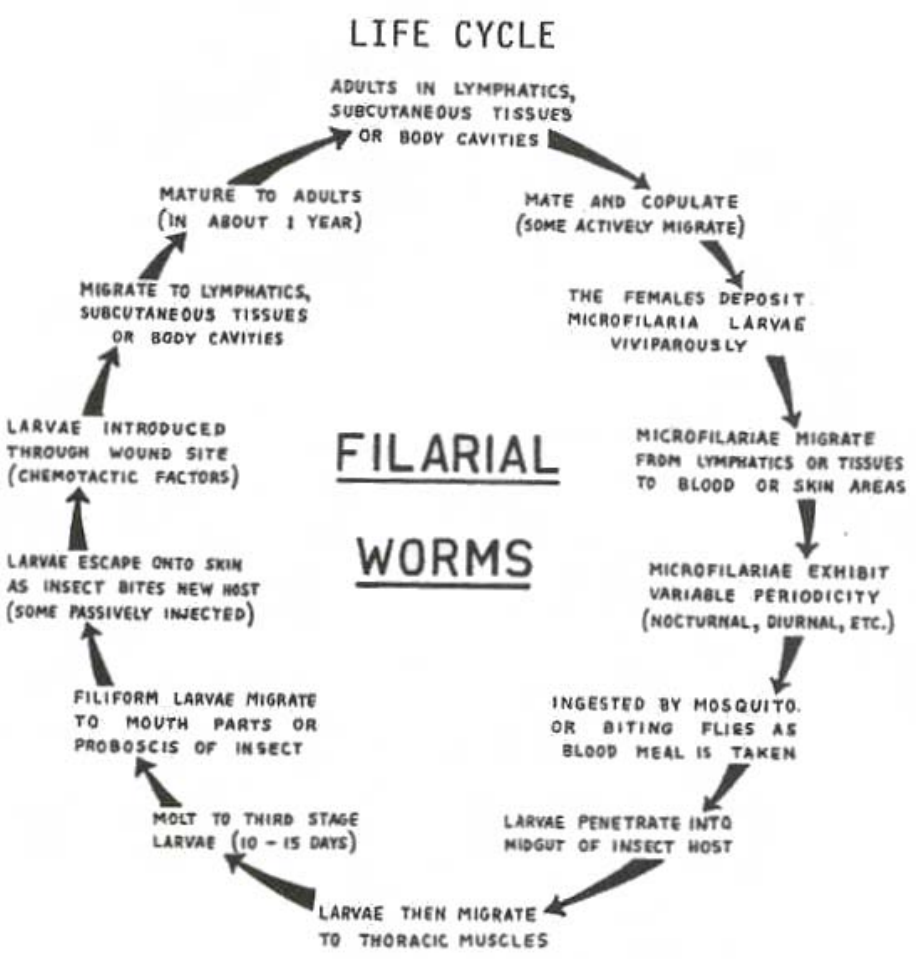

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
FILARIAL WORMS

Figure 4-30. Life cycle of Wuchereria bancrofti. (continued)

## Wuchereria bancrofti Continued

### MICROFILARIA

SIZE: 230 to 296 mcm.
SHEATH: Present.
TAIL: Blunt.
TERMINAL NUCLEI: Do not extend to the tip of the tail.

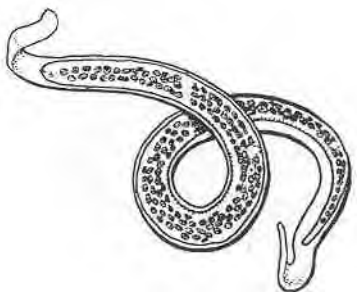


Figure 4-30. Life cycle of Wuchereria bancrofti. (concluded)

## ORGANISM 2: Brugia malayi

### GENERAL CHARACTERISTICS

COMMON NAME: Malayan filariasis, elephantiasis worm.
GEOGRAPHICAL DISTRIBUTION: Worldwide, prevalent in tropics and subtropics.
PATHOGENESIS: Elephantiasis, fibrosis, thrombi, lymphatic inflammation, granulomatous infiltration.
HABITAT: Lymphatic system.
VECTOR: Mosquitoes.
RESERVOIR HOST: None.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: Nocturnal with some subperiodic strains.
SPECIMEN OF CHOICE: Blood.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 177 to 260 mcm.
SHEATH: Present.
TAIL: Swollen tip.
TERMINAL NUCLEI: Two terminal, separated nuclei.

## Brugia malayi (continued)

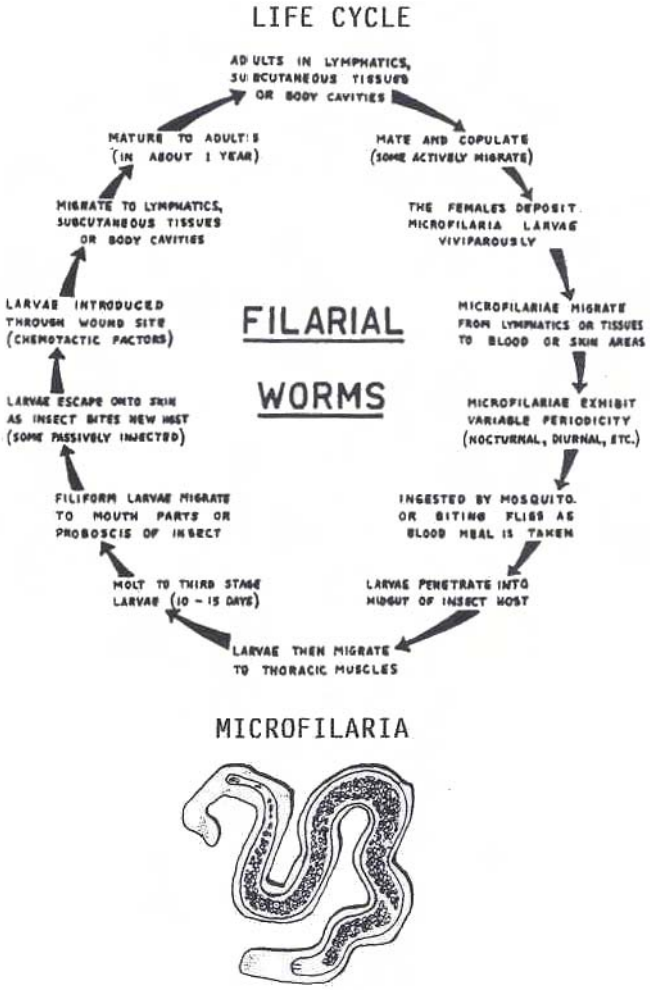

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
FILARIAL WORMS
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MICROFILARIA

Figure 4-31. Life cycle of Brugia malayi.

## ORGANISM 3: Loa loa

### GENERAL CHARACTERISTICS

COMMON NAME: Eyeworm.
GEOGRAPHICAL DISTRIBUTION: Africa.
PATHOGENESIS: Swelling, urticaria, fever, neurologic symptoms, allergenic responses, irritation and destruction of ocular tissues.
HABITAT: Lymphatic system.
VECTOR: Chrysops species.
RESERVOIR HOST: Monkeys.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: Diurnal.

## Loa loa (continued)

SPECIMEN OF CHOICE: Blood.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 250 to 300 mcm.
SHEATH: Present.
TAIL: Pointed.
TERMINAL NUCLEI: Unbroken line of nuclei to the tip of the tail.

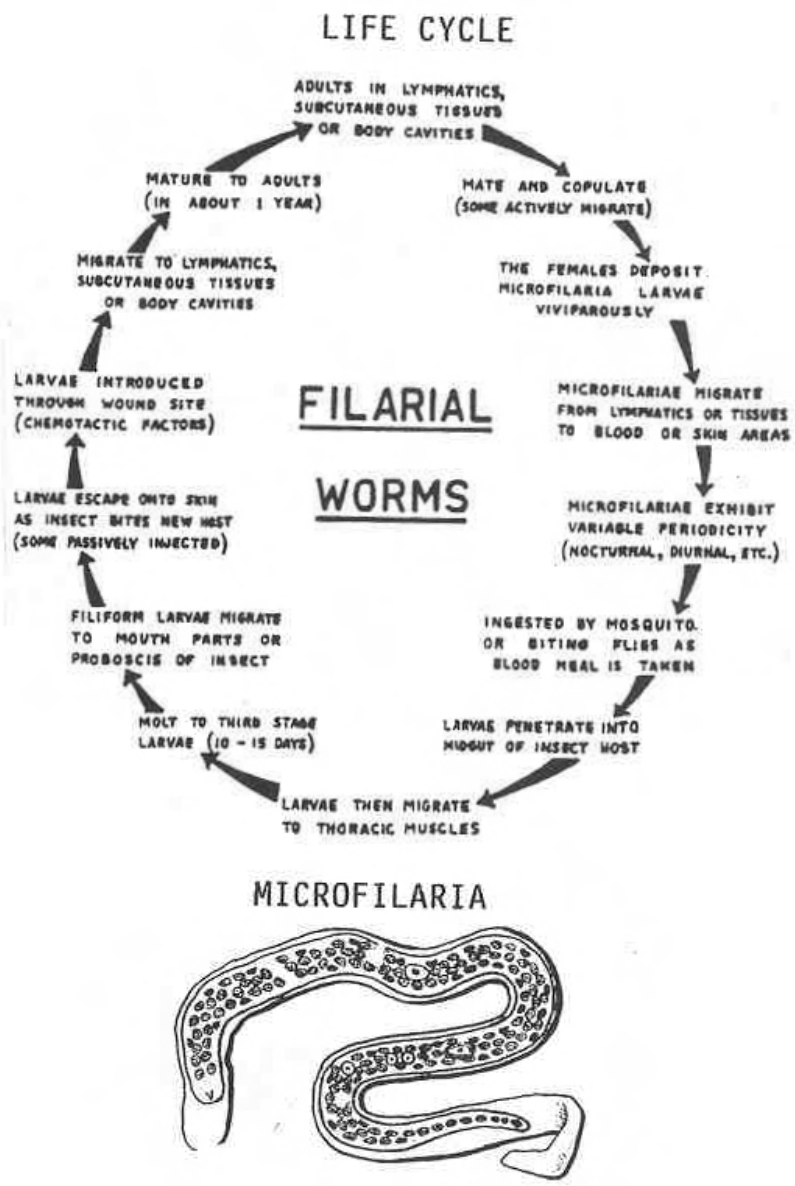

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
FILARIAL
WORMS
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MICROFILARIA

Figure 4-32. Life cycle of Loa loa.

## ORGANISM 4: Mansonella ozzardi

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Central and South America.
PATHOGENESIS: Usually asymptomatic, mild discomfort with eosinophilia and articular pain.
HABITAT: Mesenteries and fatty tissue of the body cavities.
VECTOR: Culicoides species.
RESERVOIR HOST: None.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: None.
SPECIMEN OF CHOICE: Blood.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 173 to 240 mcm.
SHEATH: Absent.
TAIL: Blunt.
TERMINAL NUCLEI: Do not extend to the tip of the tail.

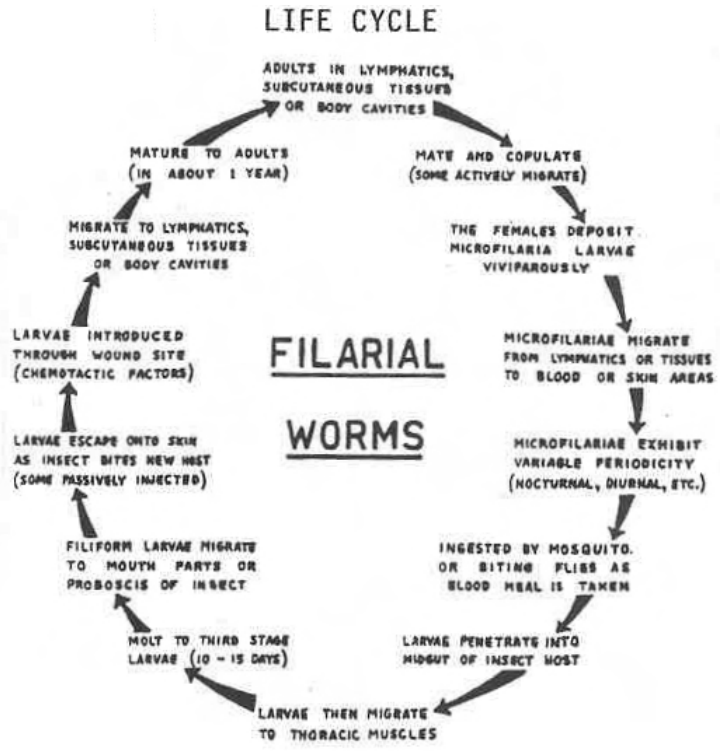

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
FILARIAL WORMS

Figure 4-33. Life cycle of Mansonella ozzardi. (continued)

**Mansonella ozzardi continued)**

Figure 4-33. Life cycle of Mansonella ozzardi. (concluded)

## ORGANISM 5: Mansonella perstans

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: South America and African tropics.
PATHOGENESIS: Mild vertigo, fever, edema, and abdominal and pectoral pain.
HABITAT: Deep connective tissue of the body cavity.
VECTOR: Culicoides species.
RESERVOIR HOST: Chimps and gorillas.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: None.
SPECIMEN OF CHOICE: Blood.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 190 to 200 mcm.
SHEATH: Absent.
TAIL: Blunt.
TERMINAL NUCLEI: Extend to the tip of the tail.

## Mansonella perstans (continued)

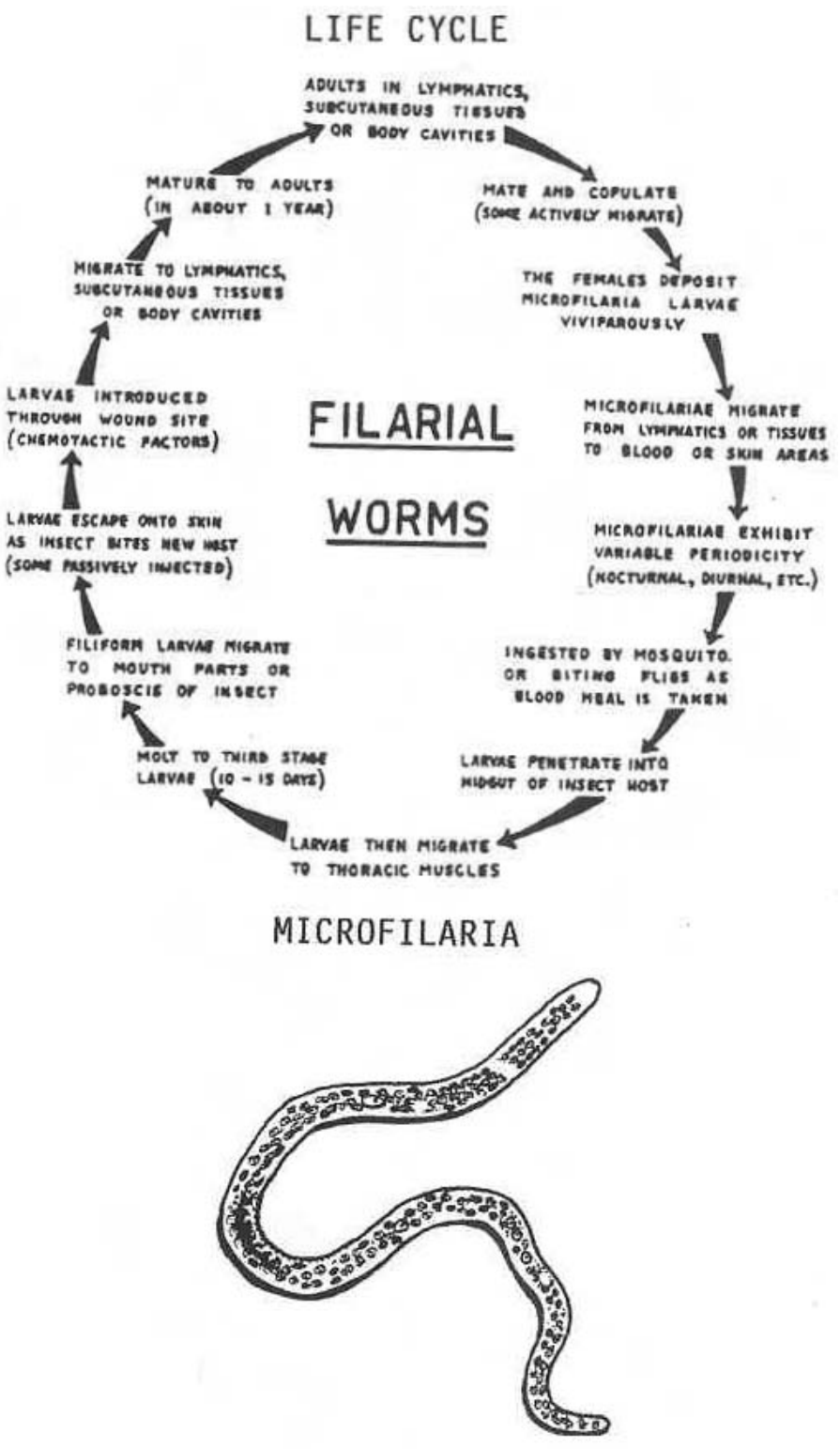

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MOLT TO THIRD STAGE LARVAE (10 – 15 DAYS)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
FILARIAL WORMS
MICROFILARIA

Figure 4-34. Life cycle of Mansonella perstans.

## ORGANISM 6: Mansonella streptocerca

### GENERAL CHARACTERISTICS

COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: West Africa.
PATHOGENESIS: Pruritic rash.
HABITAT: Cutaneous tissue of the body trunk.
VECTOR: Culicoides species.
RESERVOIR HOST: Chimpanzees.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: None.
SPECIMEN OF CHOICE: Skin biopsies.
SPECIMEN PROCESSING: Giemsa's.or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 180 to 240 mcm.
SHEATH: Absent.
TAIL: Blunt, bent in a shepherd's.crook.
TERMINAL NUCLEI: Extend to.the tip of the tail.

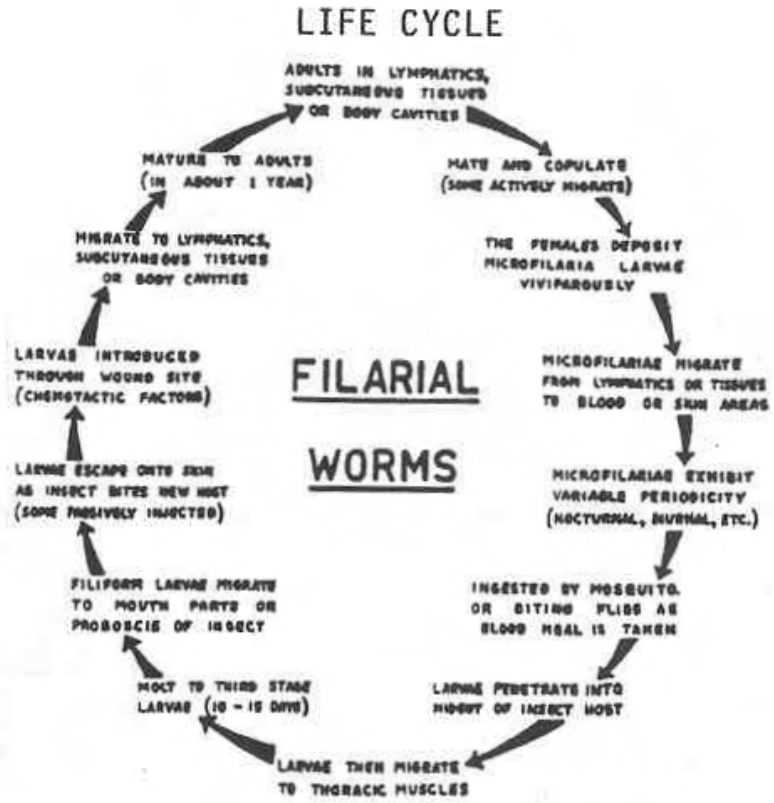

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
FILARIAL
WORMS
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
LARVAE PENETRATE INTO THORAX OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES

Figure 4-35. Life cycle of Mansonella streptocerca. (continued)

## Mansonella streptocerca (continued)

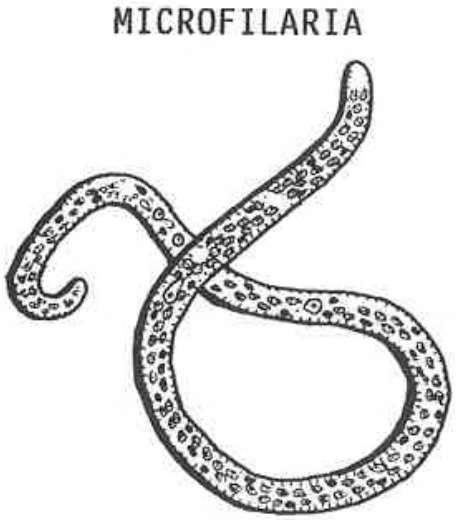



Figure 4-35. Life cycle of Mansonella streptocerca. (concluded)

## ORGANISM 7: Onchocerca volvulus

### GENERAL CHARACTERISTICS

COMMON NAME: Blinding filariasis, river blindness.
GEOGRAPHICAL DISTRIBUTION: Central and northern South America and Africa.
PATHOGENESIS: Cutaneous nodules, ocular lesions, pectoral pain, blindness.
HABITAT: Cutaneous and subcutaneous tissues.
VECTOR: Simulium species.
RESERVOIR HOST: None.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: None.
SPECIMEN OF CHOICE: Tissue biopsies.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 220 to 260 mcm.
SHEATH: Absent.
TAIL: Blunt and slightly curved.
TERMINAL NUCLEI: Do not extend to the tip of the tail.

## Mansonella streptocerca (continued)

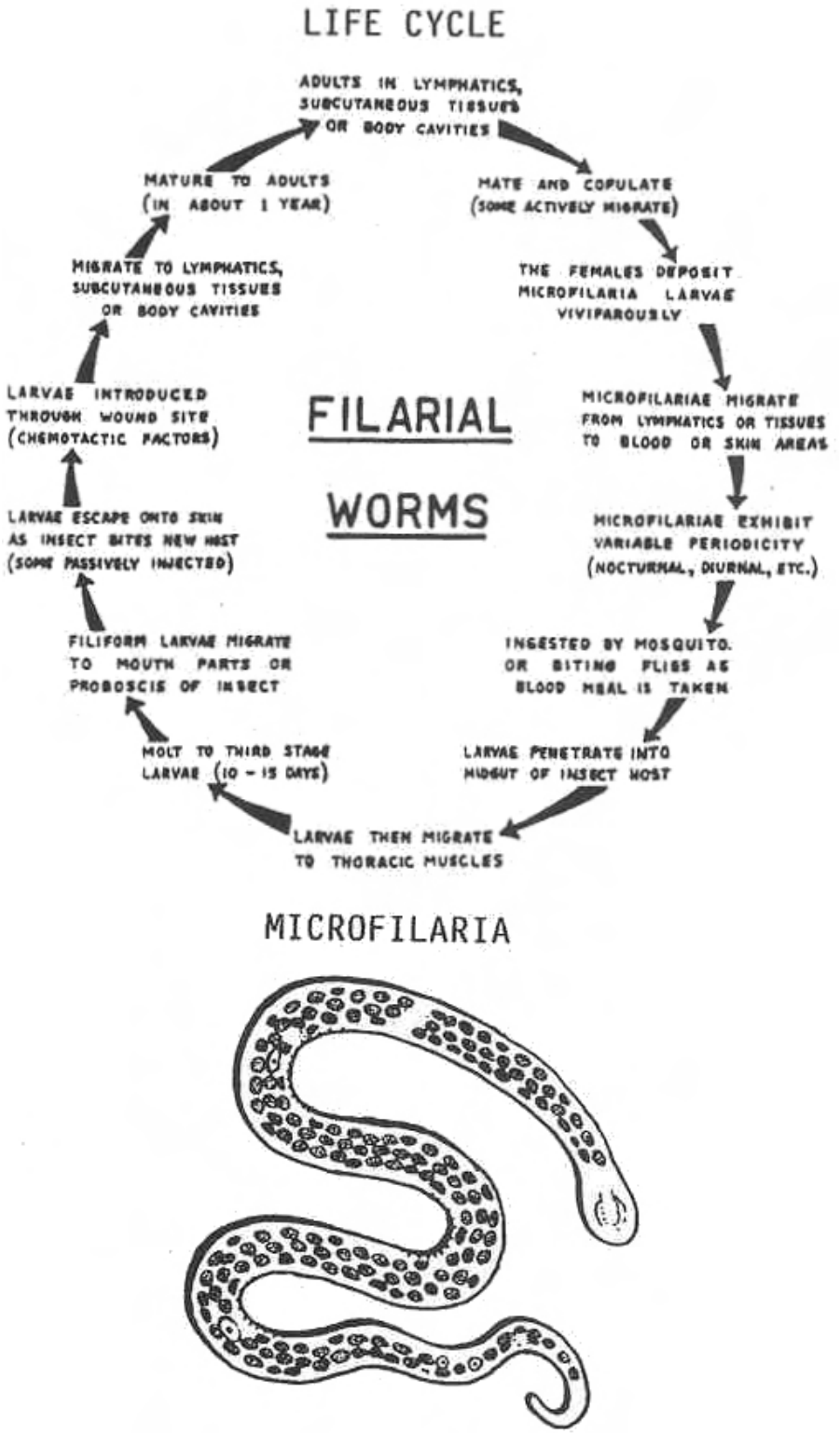

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
FILARIAL
WORMS
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MICROFILARIA

Figure 4-36. Life cycle of Onchocerca volvulus.

## ORGANISM 8: Dirofilaria immitis

### GENERAL CHARACTERISTICS

COMMON NAME: Dog heartworm.
GEOGRAPHICAL DISTRIBUTION: Worldwide, prevalent in tropics and subtropics.
PATHOGENESIS: In dogs: chronic endocarditis; in humans: granulomas and pneumonitis.
HABITAT: Heart and lungs.
VECTOR: Mosquitoes.
RESERVOIR HOST: Dogs, which are the definitive hosts.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: None.
SPECIMEN OF CHOICE: Blood.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

### MICROFILARIA

SIZE: 285 to 315 mcm.
SHEATH: Absent.
TAIL: Slender and pointed.
TERMINAL NUCLEI: Do not extend to the tip of the tail.

## Dirofilaria immitis (continued)

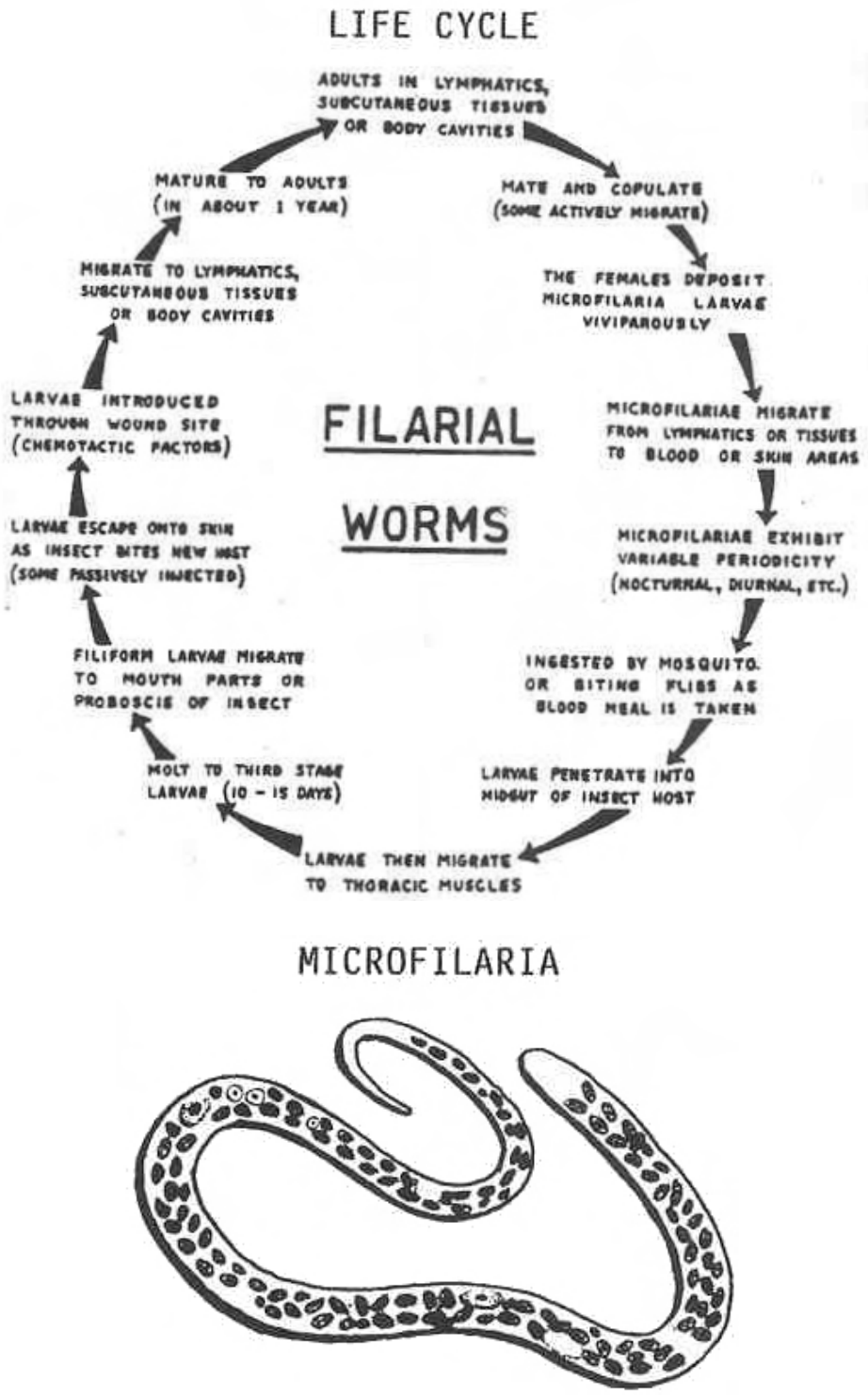

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES
MOLT TO THIRD STAGE LARVAE (10 – 15 DAYS)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
FILARIAL WORMS
MICROFILARIA

Figure 4-37. Life cycle of Dirofilaria immitis.

## ORGANISM 9: Dirofilaria conjunctivae

### GENERAL CHARACTERISTICS

A group of non-patent Dirofilariae.
COMMON NAME: None.
GEOGRAPHICAL DISTRIBUTION: Worldwide, endemic in the USA.
PATHOGENESIS: Tumors and abcesses in various anatomical sites not completely understood.
HABITAT: Various anatomical sites.
VECTOR: Mosquitoes.
RESERVOIR HOST: Raccoons and dogs, which are the definitive hosts.
INFECTIVE FORM: Filariform larva.
MODE OF INFECTION: Inoculation.
PERIODICITY: None.
SPECIMEN OF CHOICE: Biopsies.
SPECIMEN PROCESSING: Giemsa's or Hematoxylin/Eosin stains.

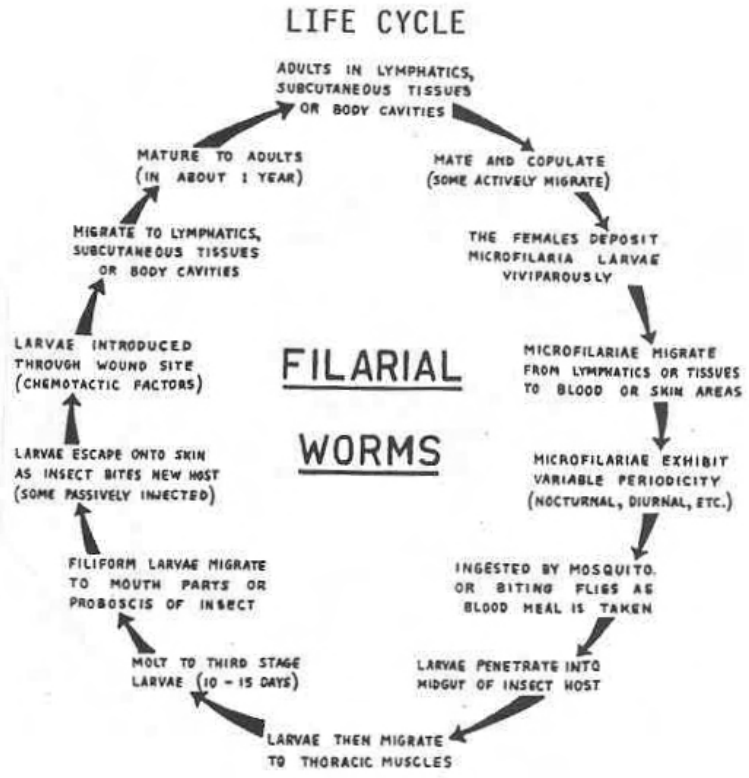

LIFE CYCLE
ADULTS IN LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
MATURE TO ADULTS (IN ABOUT 1 YEAR)
MATE AND COPULATE (SOME ACTIVELY MIGRATE)
MIGRATE TO LYMPHATICS, SUBCUTANEOUS TISSUES OR BODY CAVITIES
THE FEMALES DEPOSIT MICROFILARIA LARVAE VIVIPAROUSLY
LARVAE INTRODUCED THROUGH WOUND SITE (CHEMOTACTIC FACTORS)
FILARIAL WORMS
MICROFILARIAE MIGRATE FROM LYMPHATICS OR TISSUES TO BLOOD OR SKIN AREAS
LARVAE ESCAPE ONTO SKIN AS INSECT BITES NEW HOST (SOME PASSIVELY INJECTED)
MICROFILARIAE EXHIBIT VARIABLE PERIODICITY (NOCTURNAL, DIURNAL, ETC.)
FILIFORM LARVAE MIGRATE TO MOUTH PARTS OR PROBOSCIS OF INSECT
INGESTED BY MOSQUITO OR BITING FLIES AS BLOOD MEAL IS TAKEN
MOLT TO THIRD STAGE LARVAE (10 - 15 DAYS)
LARVAE PENETRATE INTO MIDGUT OF INSECT HOST
LARVAE THEN MIGRATE TO THORACIC MUSCLES

Figure 4-38. Life cycle of Dirofilaria conjunctivae.

### MICROFILARIA

The identification criteria of this group of organisms have not been established because they vary within the species

## Section II. PHYLUM ACANTHOCEPHELMINTHES

### 4-4. GENERAL DESCRIPTION

This phylum was once considered a class of the phylum Aschelminthes. The species in this phylum are all parasitic and there are two potential pathogens to man: Macracanthorhynchus hirudinaceus, and Moniliformis moniliformis. They are commonly known as thorny headed worms. Some writers believe that this phylum is an evolutionary link between the flat and the round worms. The worms have an anterior retractile armed proboscis with 5 to 6 rows of spines. The digestive tract is absent and they absorb nutrients through the skin. The cuticle is folded and creased showing some pseudosegmentation. Only Macracanthorhynchus hirudinaceus will be presented in this text.

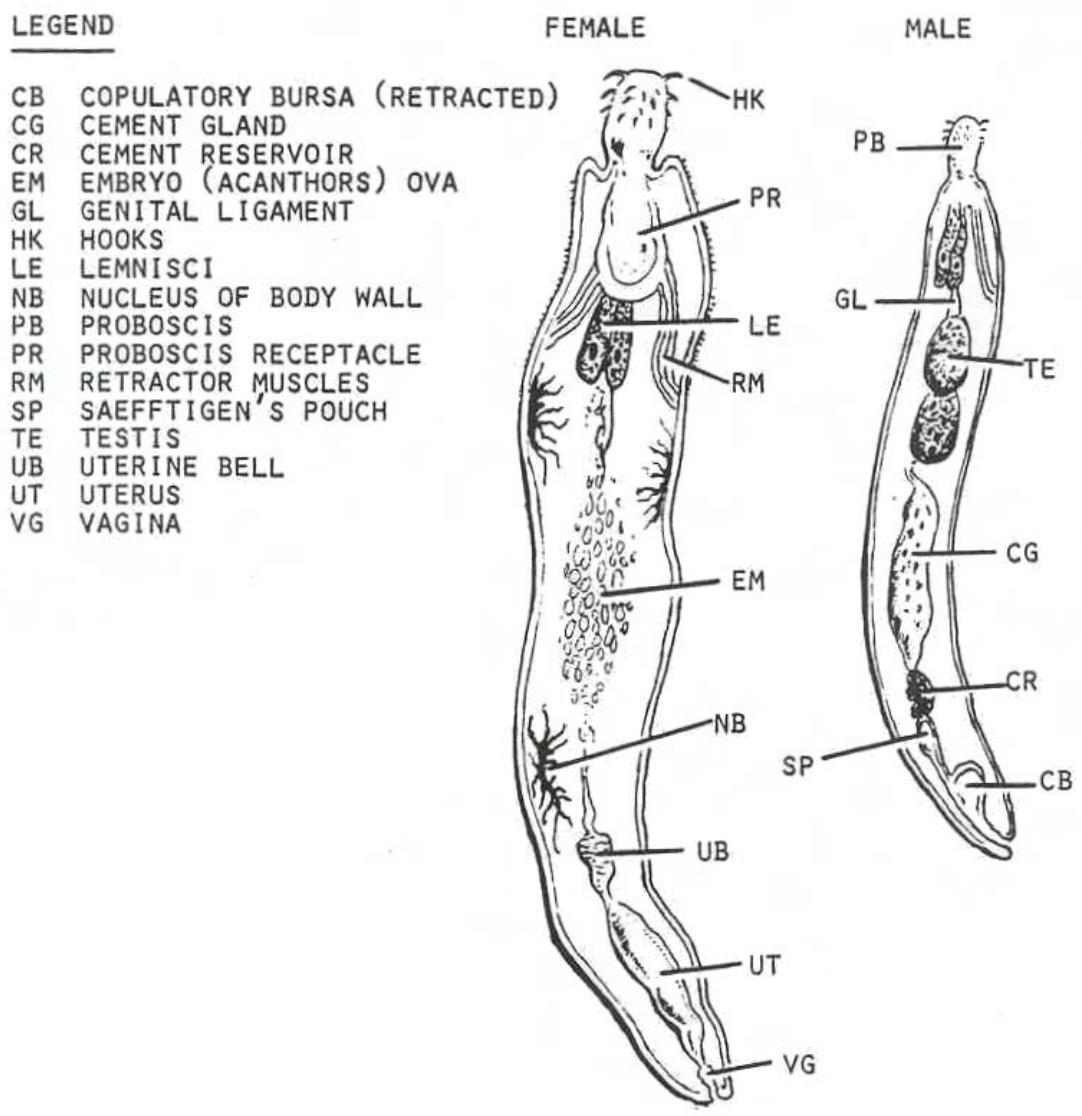



Figure 4-39. Morphology of Acanthocephalans.

## 4-5. MACRACANTHORHYNCHUS HIRUDINACEUS

This organism has been called the giant thorny-headed worm. Although little clinical history is available concerning acanthocephalan infections in humans, varying degrees of inflammation along the intestinal mucosa have been described. Oleoresin of aspidium has been successfully employed as a treatment for adults, while mebendazole is recommended for children. The geographical distribution of this organism is worldwide.

HABITAT: Small intestines.
INTERMEDIATE HOST: Beetle larvae (grubs).
RESERVOIR HOST: Swine (usual definitive host).
INFECTIVE FORM: Cystacanth.
MODE OF INFECTION: Ingestion.

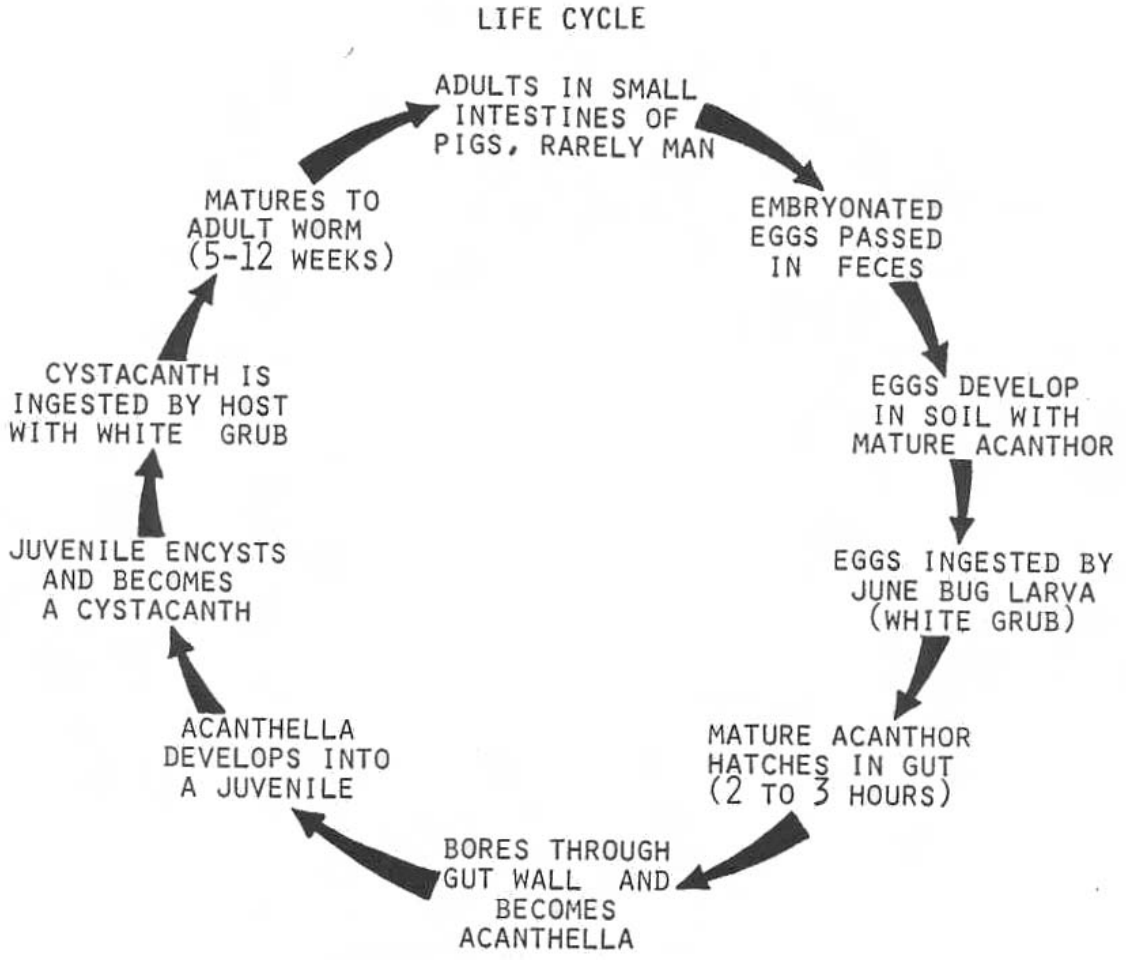
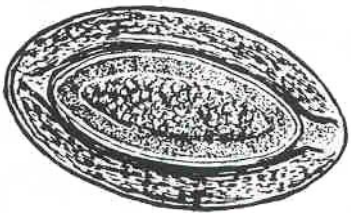

LIFE CYCLE
ADULTS IN SMALL INTESTINES OF PIGS, RARELY MAN
EMBRYONATED EGGS PASSED IN FECES
EGGS DEVELOP IN SOIL WITH MATURE ACANTHOR
EGGS INGESTED BY JUNE BUG LARVA (WHITE GRUB)
MATURE ACANTHOR HATCHES IN GUT (2 TO 3 HOURS)
BORES THROUGH GUT WALL AND BECOMES ACANTHELLA
ACANTHELLA DEVELOPS INTO A JUVENILE
JUVENILE ENCYSTS AND BECOMES A CYSTACANTH
CYSTACANTH IS INGESTED BY HOST WITH WHITE GRUB
MATURES TO ADULT WORM (5-12 WEEKS)

Figure 4-40. Life cycle of Macracanthorhynchus hirudinaceus.

## Macracanthorhynchus hirdudinaceus (continued)

### OVA

SIZE: 60 x 90 mcm.
SHAPE: Ellipsoidal.
COLOR: Brown.
OPERCULUM: Absent.
CONTENT: Acanthor larva.
SHELL WALL: Heavy with three embryonic layers.



### ADULT

SIZE
MALE: 50 to 100 by 4 mm.
FEMALE: 200 to 650 by 7 mm.

SHAPE: Flattened ventrodorsally; cylindrical when preserved; pseudosegmented.
COLOR: Milky white.
RETRACTILE ARMED PROBOSCIS: 5 to 6 rows of spines.
DIGESTIVE SYSTEM: Absent.
CUTICLE: Folded and creased.

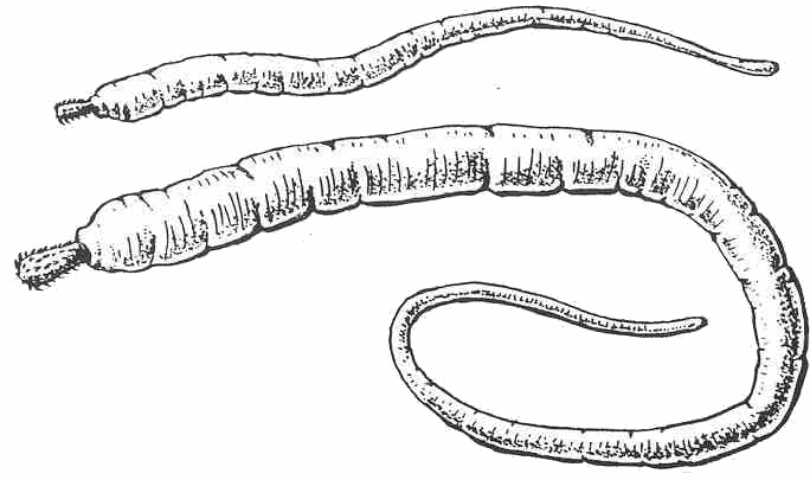


Figure 4-41. Stages of Macracanthorhynchus hirudinaceus.

## Section III. ARTHROPOD AND VECTORS

### 4-6 GENERAL COMMENTS

The role of various species of insects, lice, ticks, mites and other arthopods as vectors of disease, or as agents directly responsible for human discomfort, is of considerable significance in the study of parasites. Indeed, many of the parasites presented in the previous sections depend solely upon arthropods as a means of transmission from one host to another. For example, copepods are the intermediate hosts in the life cycles of the fish tapeworm, Diphyllobothrium latum, Spirometra species and the guinea worm, Dracunculus medinesis; the female anopheline mosquitoes are responsible for carrying the dreaded malarial parasites; African trypanosomiasis could not be transmitted without the lowly tsetse fly, and Chagas' disease would be nearly eradicated if it were not for the blood sucking family of reduviid bugs.

### 4-7. MORPHOLOGICAL CHARACTERISTICS

Because of their involvement in the establishment of various disease entities, it is desirable that the parasitology technician recognize the overt appearance of various arthropod species and be able to identify certain general morphological characteristics. The following pages contain illustrations of the prominent features of some of the most important arthropod vectors and agents.

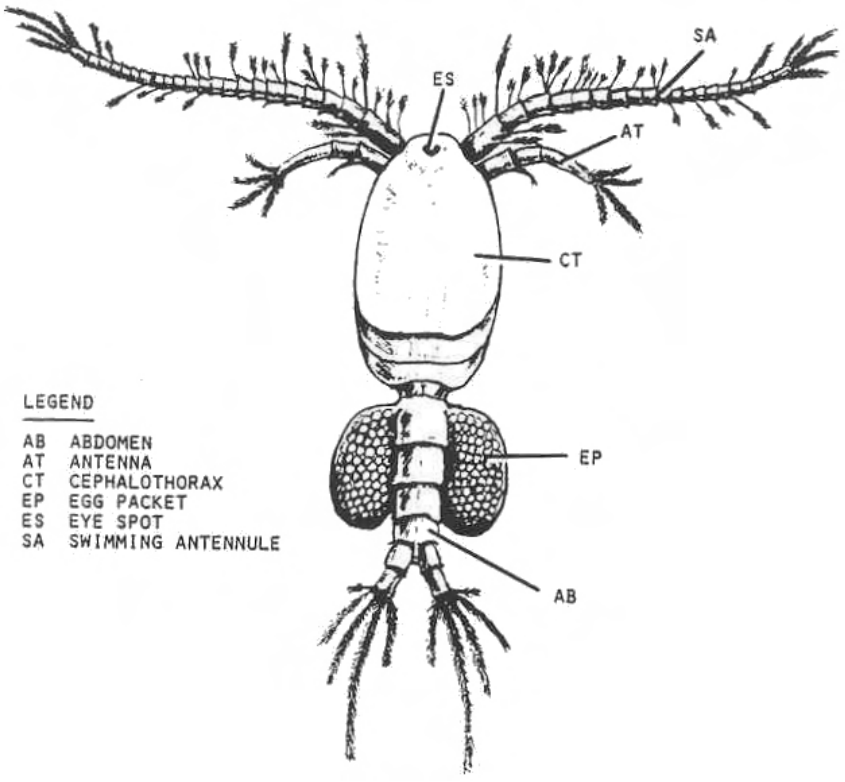



Figure 4-42. Morphology of a Copepod.

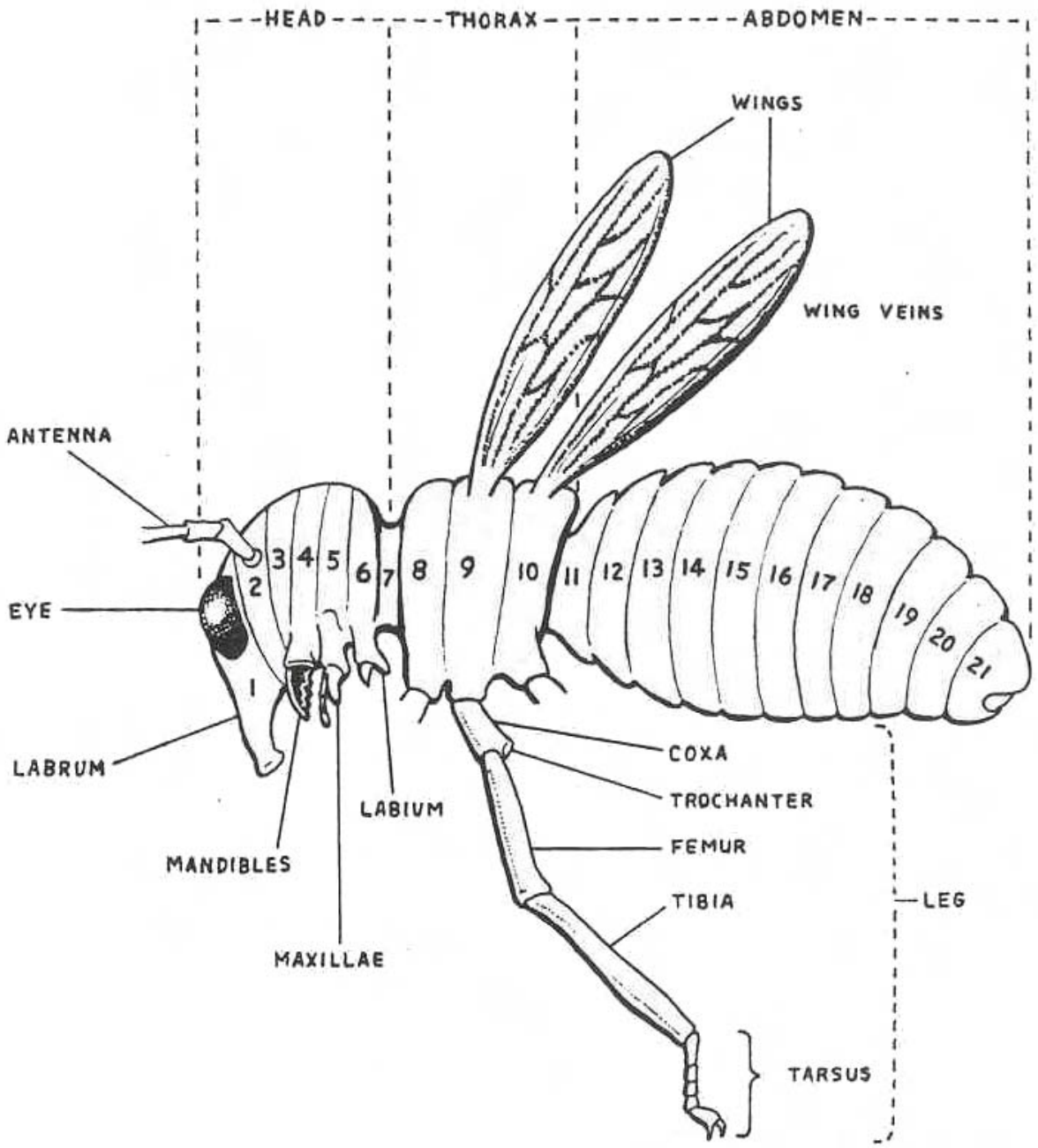



Figure 4-43. Diagram of a primitive insect.

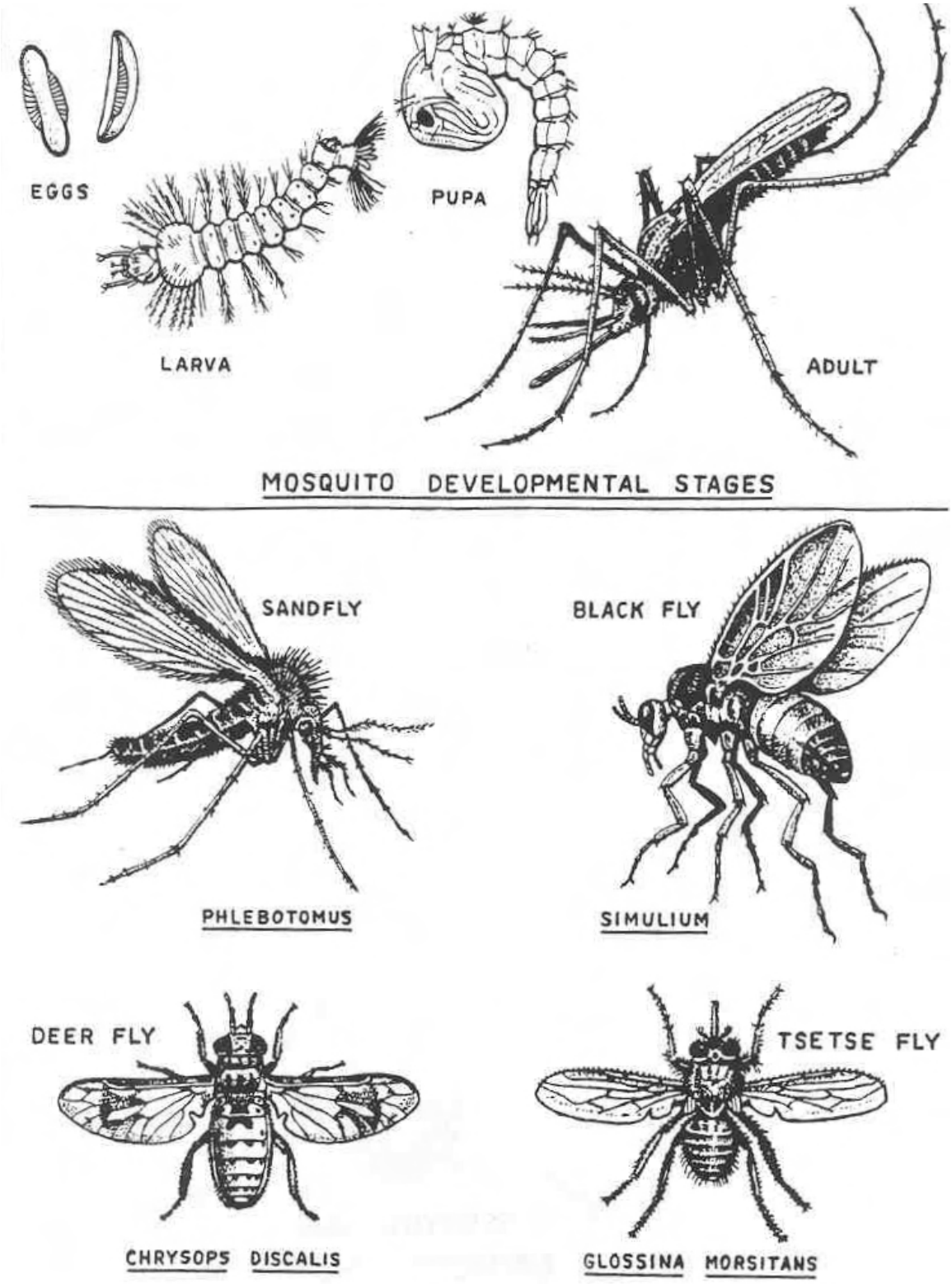



Figure 4-44. Examples of common arthropod vectors.

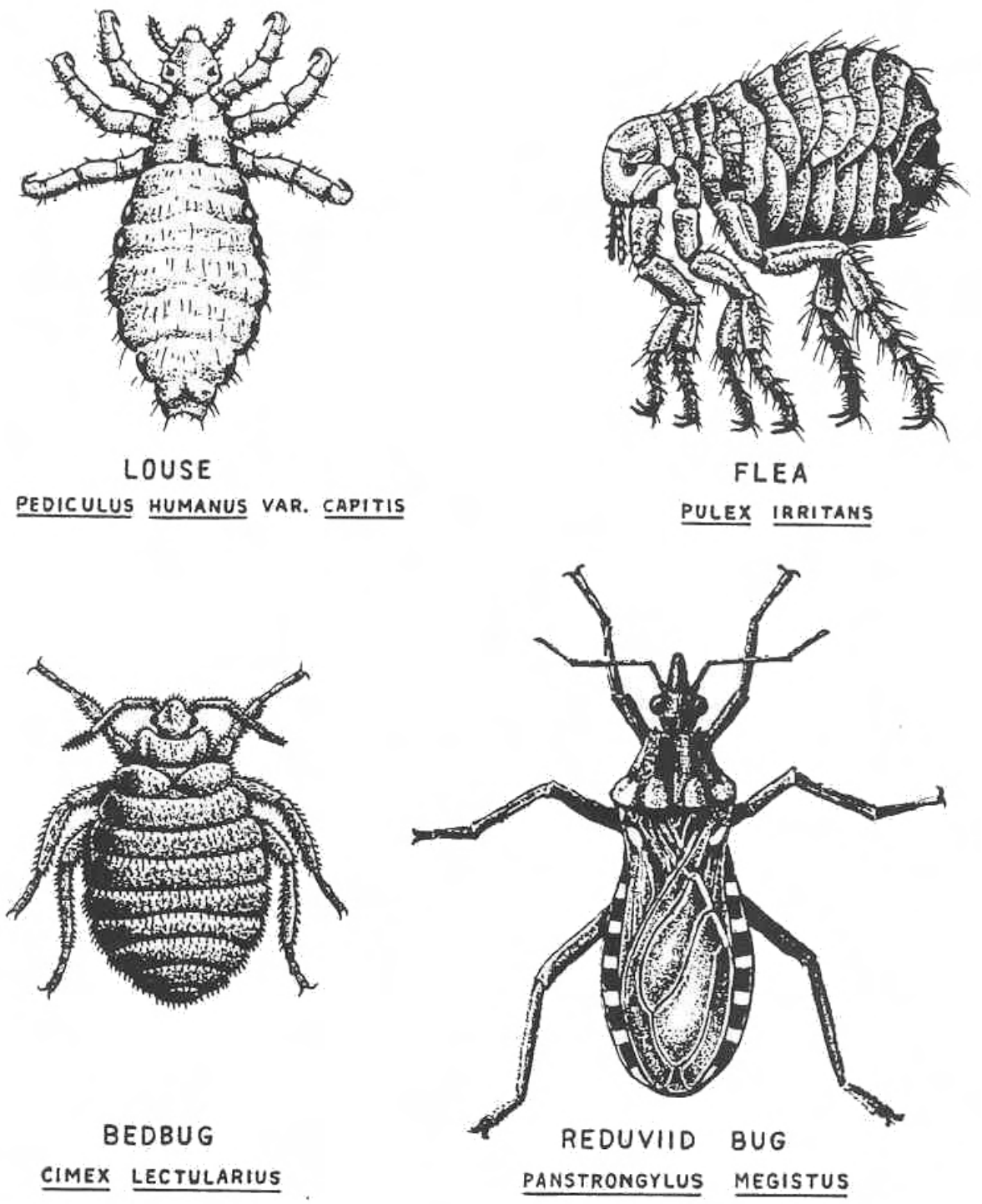



Figure 4-45. Examples of common arthropod vectors.

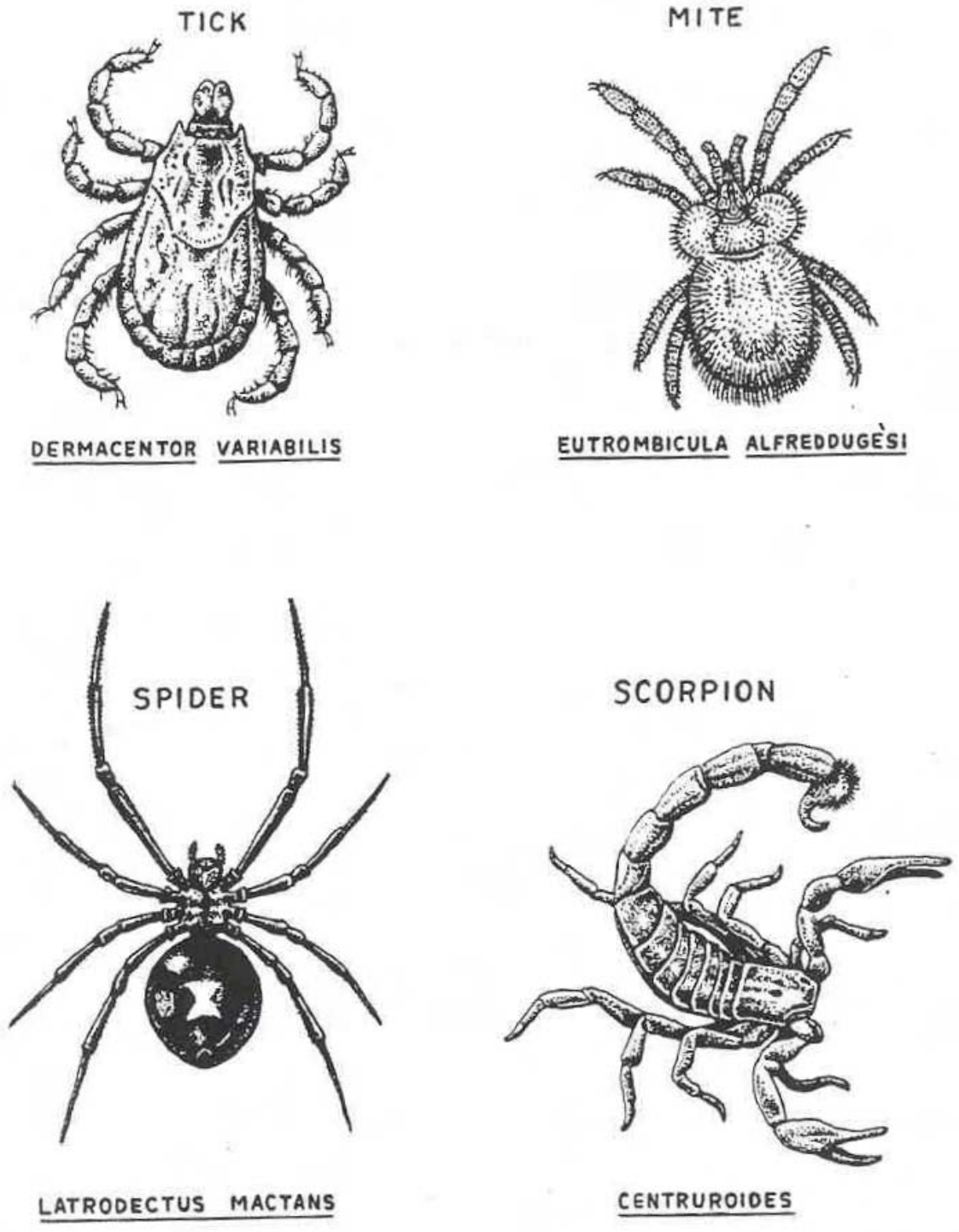



Figure 4-46. Examples of common arthropod vectors.

**Continue with Exercises**

**EXERCISES, LESSON 4**

**INSTRUCTIONS:** Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which of the following is true of members of the Phylum Acanthocephelminthes?

   a. All are parasitic.

   b. Lack digestive organs.

   c. Are considered as a class of Phylum Aschelminthes.

   d. All of the above.

2. The habitat of Macracanthorhynchus hirudinaceus is the:

   a. Connective tissue.

   b. Large intestine.

   c. Small intestine.

   d. Liver.

3. Familiarity with the morphology of arthropod vectors is desirable because of their role in disease transmission.

   a True.

   b False.

4. Which of the following statements best describe a characteristic of the Class Nematoda?

   a. The reproductive system is monoecious.

   b. Contains most of the round worms parasitic to man.

   c. The cuticle is used for attachment to the host.

   d. The males are smaller than the females.

5. An indication of fertilization of the eggs of Ascaris lumbricoides is:

   a. When the eggs become corticated.

   b. When the yolk mass is pulled away from the shell wall.

   c. When the eggs become decorticated.

   d. When the yolk mass fills the egg.

6. The organism which is most prevalent in helminth infections is:

   a. Trichuris trichiura.

   b. Ascaris lumbricoides.

   c. Necator americanus.

   d. Taenia solium.

7. What is the infective form of Enterobius vermicularis?

   a. Cercaria.

   b. Embryonated egg.

   c. Filariform larva.

   d. Encysted larva.

8. The common name for Trichuris trichiura is:

   a. Pinworm.

   b. Hookworm.

   c. Whipworm.

   d. Threadworm.

9. The organism responsible for creeping eruption is:

   a. Toxocara canis.

   b. Strongyloides stercoralis.

   c. Trichinella spiralis.

   d. Ancylostoma species.

10. Which of the following organisms is frequently associated with visceral larval migrans?

    a. Trichinella spiralis.

    b. Toxocara species.

    c. Dracunculus medinesis.

    d. Trichostrongylus species.

11. A characteristic of blood and tissue nematodes is:

    a. Specificity for human intestines.

    b. A microfilaria stage.

    c. A rhabditiform stage.

    d. Cephalic cone.

12. The definitive host of Dirofilaria conjunctivae is a:

    a. Raccoon.

    b. Gorilla.

    c. Mosquito.

    d. Monkey.

13. Man acquires an infection of Necator americanus by:

    a. Ingestion.

    b. Inoculation.

    c. Active penetration.

    d. All of the above.

14. The nematode which is capable of two different life cycles is:

    a. Strongyloides stercoralis.

    b. Toxocara species.

    c. Loa loa.

    d. Taenia solium.

15. Trichinella spiralis infections are most likely to occur in:

    a. Tropical climates.

    b. Pork eating countries.

    c. The Western hemisphere.

    d. Cold climates.

16. Which of the following characteristics helps to distinguish the filariform larvae of Trichostrongylus species?

    a. A large genital primordium.

    b. The caudal bulb.

    c. A short buccal cavity.

    d. None of the above.

17. Which of the following is a morphological characteristic of adult males of Capillaria philippinensis?

    a. A light yellow color of the cuticle.

    b. A sharp anterior spear process.

    c. Caudal alae.

    d. All of the above.

18. What is the specimen source required to recover the eggs of Capillaria hepatica?

    a. Sputum.

    b. Feces.

    c. Perianal swab.

    d. Liver biopsy.

19. Adults of Ancylostoma duodenale exhibit:

    a. Three prominent tips.

    b. A pair of cutting plates.

    c. Two prominent pairs of teeth.

    d. All of the above.

20. What specimen would you obtain to recover identification forms of Dracunculus medinesis?

    a. Exudate from irrigated lesions.

    b. Liver biopsy.

    c. Random fecal specimen.

    d. None of the above.

21. One of the classic signs of disease caused by Bancroft's filaria is:

    a. Periorbital edema.

    b. Elephantiasis.

    c. Creeping eruption.

    d. Perianal irritation.

22. Specimens being processed for the identification of blood or tissue nematodes are frequently stained with:

    a. Hematoxylin/Eosin stain.

    b. Giemsa stain.

    c. Hematoxylin/Eosin or Giemsa stain.

    d. Hematoxylin/Eosin followed by Giemsa stain.

23. An unsheathed microfilaria with no somatic nuclei in the tip of the tail would be:

    a. Mansonella ozzardi.

    b. Brugia malayi.

    c. Mansonella streptocerca.

    d. Mansonella perstans.

24. The specimen of choice for the recovery of microfilaria of Mansonella streptocerca is:

    a. Venous blood.

    b. Skin biopsies.

    c. Capillary blood.

    d. Duodenal aspirates.

25. Which of the following characteristics aids in distinguishing adults of Macracanthorhynchus hirudinaceus from Ascaris lumbricoides?

    a. Body shape tapers to a slender posterior region.

    b. Proboscis with 5 to 6 rows of spines.

    c. Cuticle with folds and creases.

    d. All of the above.

**Check Your Answers on Next Page**

**SOLUTIONS TO EXERCISES, LESSON 4**

1. a (para 4-4)
2. c (para 4-5)
3. a (para 4-6)
4. d (para 4-1)
5. b (para 4-2A; org 1)
6. b (para 4-2A; org 1)
7. b (para 4-2A; org 3)
8. c (para 4-2A; org 2)
9. d (para 4-2B; org 2)
10. b (para 4-2B; org 1)
11. b (para 4-3)
12. a (para 4-3; org 9)
13. c (para 4-2A; org 7)
14. a (para 4-2A; org 8)
15. b (para 4-2B; org 4)
16. b (para 4-2A; org 4)
17. d (para 4-2A; org 5)
18. d (para 4-2B; org 3)
19. c para 4-2A; org 6)
20. a (para 4-3; org 5)

21. b (para 4-3; org 1)

22. c (para 4-3; org 1-5)

23. a (para 4-3; org 46)

24. b (para 4-3; org 66)

25. d (para 4-510)

**End of Lesson 4**

# APPENDIX A

## Clinical Manifestations and Treatment

## of the Common Parasitic Diseases

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| INTESTINAL AND ATRIAL PROTOZOAN INFECTIONS | | | | |
| Amoebiasis amoebic dysentery. | Entamoeba histolytica (amoeba) | Asymptomatic (carriers) Incubation period (1-14 weeks) vague unlocalized discomfort. Intestinal symptoms: abdominal pain, alternating diarrhea and constipation, dysentery (stools with blood, mucous). Chronic-ulcerative colitis: recurrent dysentery, gastro-intestinal disturbances Extraintestinal symptoms: Fever (100° to 102° F), dehydration, toxemia, tenderness. | Intestinal lesions: ulcerative process (flask-like), regenerative proliferation of cells, secondary bacterial infection; amoebic granulomas (amoebomas). Extraintestinal: systemic amebiasis, amebic hepatitis (85 percent in right lobe), pulmonary abscess, fistulas, fissures, abscesses of brain and spleen. | Metronidazole (Flagyl), tetracycline, diiodohydroxyquin. Metronidazole dehydroemitine, emetine, plus chloroquine. |
| Amoebic dysentery. | Dientamoeba fragilis (flagellate) | Usually asymptomatic. Gastrointestinal disturbances. Persistent diarrhea. | Inflammation of intestinal mucosa. | Diiodohydroxyquin tetracycline. |
| Giardiasis. | Giardia lamblia (flagellate) | Usually asymptomatic, may be varied gastrointestinal symptoms, weight loss. | Catarrhal inflammation of mucosa, inhibits absorption of vitamin A and fats. | Quinacrine Metronidazole. |
| Trichomoniasis. | Trichomonas vaginalis (flagellate) | Usually asymptomatic, may be burning sensation, itching, frothy-creamy discharge. | Persistent vaginitis (toxicity), nonspecific urethritis, prostato-vesiculitis. | Metronidazole (Flagyl). |
| Balantidiasis. | Balantidium coli (ciliate) | Alternating diarrhea and constipation, mucous, blood, pus, tender colon. | Necrotic ulcers (flask-like) abscesses of mucosa and submucosa, anemia. | Oxytetracycline, Diiodohydroxy-quinoline, carbarsome or chlorotetracycline. |
| Coccidiosis. | Isospora belli (coccidians) | Usually asymptomatic, may be abdominal pain and discomfort, diarrhea, undigested food, steatorrhea, fever and weakness. | Inflammation of the intestinal mucosa. | No chemotherapy. Rest and bland diet. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| **BLOOD AND TISSUE PROTOZOAN INFECTIONS** | | | | |
| Visceral leishmaniasis/kala-azar. | *Leishmania donovani* (flagellate) | Chills, fever, vomiting, malaise, protrusion of the abdomen, dyspnea. | Anemia, edema, hemorrhage of mucous membranes, hepatosplenomegaly, leukopenia. | Antimony compounds, stibogluconate, pentamidine. |
| Cutaneous leishmaniasis, oriental sore. | *Leishmania tropica* (flagellate) | Chills and fever, skin irritation. | Small, red papule; plague-like lesions, diffused; nodules; cellular infiltration; secondary lesions. | Quinacrine (early), Neostibosan (advanced). |
| Mucocutaneous leishmaniasis, Espundia, uta, Chiclero ulcer. | *Leishmania brazilien-sis* (flagellate) | Malaise, itching, fever, nasal obstruction. | Small red papule, granular lesion, lesions on the ear, ulceration of mucous membranes, necrosis, hyper-chromic anemia. | Neostibasan. Pentamidine. |
| African trypano-somiasis; sleeping sickness. | *Trypanosoma brucei* (*gambiense* and *rhodesiense*) (flagellate) | Generalized pain, headache, fever, cramps, weakness, swollen lymph nodes, Winterbottoms' sign, retar-dation, lethargy. | Central Nervous System disorders, paralysis, convulsions, infiltration of tissue cells, diffused meningo-encephalitis and meningomyelitis, heart failure. | Arsenicals, pentamidine or suramin (early), melarsoprol or tryparsamide (late). |
| American trypano-somiasis; Chagas' disease. | *Trypanosoma cruzi* (flagellate) | Chills; loss of strength, muscle and bone pain; swollen regional lymph nodes; swelling of preauricu-lar lymph nodes (Romana's sign). | Proliferative inflammatory reac-tions; anemia; nervous disorders; edema of eyelid and conjunctiva; megaesophagus or megacolon; heart failure. | Chemotherapy not effective against tissue forms. Aminoquinolines (blood forms); Bayer 2502 and nitrofurans, amphotericin B (promising). |
| Toxoplasmosis. | *Toxoplasma gondii* (coccidian) | Usually asymptomatic. Congenital: stiff neck, retraction of head, spasticity, paralysis.<br>Mild form: malaise, muscle pain, low fever,<br>Acute: rash, high fever, chills, prostration,<br>Chronic: vague, weakness, weight loss, headache, diarrhea. | Chorioretinitis, hydrocephaly, microcephaly, psychomotor distur-bances, convulsions.<br>Anemia, lymphadenopathy, lympho-cytosis.<br>Meningoencephalitis, hepatitis, pneumonitis, myocarditis.<br>Retinochoroiditis, posterior uveitis. | Pyrimethamine plus Trisulfapyrimi-dines. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| **BLOOD AND TISSUE PROTOZOAN INFECTIONS** | | | | |
| Primary Amebic Meningoencephalitis. | Naegleria spp.<br>Hartmanella spp.<br>Acanthamoeba spp. (Amoeba) | Severe frontal headache, sore throat, fever, blocked nose, stiff neck, Kernings sign; high WBC count. | CNS involvement with mortality in from 2-7 days; necrotic areas of meninges, brain and perivascular spaces. | Amphotericin B |
| Malaria, ague, paludism, intermittent fevers, marsh fever. | Plasmodium<br>vivax<br>ovale<br>malariae<br>falciparum<br>(sporozoan) | Acute stage--intermittent febrile paroxysms (fever-chill cycle).<br>P. vivax - 45 hours<br>P. ovale - 49 hours<br>P. malariae - 72 hours<br>P. falciparum - 36-48 hours; temperature 103°-106°; headache (periocular pain); lethargy; lack of appetite, vague pains (joints).<br>Pernicious malaria--P. falciparum: nausea; vomiting, cyanosis, kidney dysfunction (oliguria or anuria); hematuria (blackwater-fever); Hemorrhages, cerebral involvement (coma, convulsions).<br><br>Chronic stages: relapses, latency (benign), acquired immunity. | Vascular Disorders:<br>erythrocytic destruction, anemia, blockages of capillaries, anoxemia.<br><br>Tissue disorders:<br>splenomegaly, impairment of parenchymal cells, edematous lesions (kidney, brain, cardiac muscles). | Suppressive:<br>Chloroquine or amodiaquine and primaquine.<br><br>Uncomplicated:<br>Chloroquine or amodiaquine.<br><br>Severe:<br>Chloroquine hydrochloride or quinine dihydrochloride.<br><br>Prevention of relapses:<br>Primaquine.<br><br>Drug resistant:<br>Quinine sulfate plus pyrmethamine.<br>Sulfadiazine.<br>Dapsone.<br>Fansidar.<br>Mefloquine. |
| **CESTODE INFECTIONS** | | | | |
| Taeniasis, beef tapeworm infection. | Taeniarhynchus saginatus<br>(tapeworm) | Frequently asymptomatic.<br>Intestinal manifestations: abdominal pain and discomfort, diarrhea, loss of appetite (usually), nausea, vomiting. | Appendiceal mucosal lesions with secondary appendicitis, rare intestinal obstruction, moderate eosinophilia. | Niclosamide, or Quinacrine hydrochloride. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| CESTODE INFECTIONS | | | | |
| Taeniasis, pork tapeworm infection, Cysticercosis. | Taenia solium (tapeworm and its larva) | Frequently asymptomatic. Intestinal manifestations: abdominal pain and discomfort, alternating diarrhea and constipation, loss of appetite Extraintestinal manifestations: faulty nutrition; headache; nervous disorders. Cysticercosis: vague symptoms; muscular pain; disorientation; epilepsy. | Inflammation of intestinal mucosa, intestinal perforation, anemia, eosinophilia, toxemia Cysticercal lesions (sequellae) fibrous capsules, CNS malfunction; chorioretinitis, blindness, lesions of brain; calcification in tissues. | Niclosamide, or Quinacrine hydrochloride, Compazine as antiemetic, Paramomycin, Surgery for cysticercal lesions when possible. |
| Dwarf tapeworm infection. | Hymenolepis nana (tapeworm) | Often asymptomatic. Intestinal manifestations: abdominal pain; vomiting; lack of appetite. Extraintestinal manifestations: general weakness (asthenia) headache and nervous disturbances. | Variable enteritis, secondary anemia, eosinophilia. | Niclosamide, Paramomycin. |
| Rat tapeworm infection. | Hymenolepis diminuta (tapeworm) | Generally asymptomatic. Vague intestinal disturbances of short duration. | No significant pathology. | Niclosamide, vermifuges. |
| Dipylidiasis, dog tapeworm infection .. | Dipylidium caninum (tapeworm) | Usually asymptomatic, Occassionally vague symptoms in children. | No significant pathology. | Niclosamide, vermifuges. |
| Hydatid disease, Echinococcosis. | Echinococcus granulosus (unilocular larval cyst) Echinococcus multilocularis (alveolar larval cyst) (tapeworm larva) | Benign in early disease. Increasing discomfort, dependent on location of cyst; Upper epigastric pain with the liver cysts; Coughing, dyspnea, thoracic pain with the lung cysts; intracranial pressure, epilepsy with cyst in the brain, kidney dysfunction, intermittent pain and hematuria with renal cysts. Anaphylactic symptoms with ruptured cysts. | Varies with the location of cysts. Inflammatory reactions, fibrous cysts; hemorrhage; pressure necrosis of tissue, hepatic cysts often in the right lobe; cysts also in lung, kidneys, bones, brain, and other organs; may metastasize like a cancer; secondary infections, eosinophilia. Prognosis-grave. | Surgery with accessible unilocular cysts, Chemotherapy and radiology ineffective. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| **CESTODE INFECTIONS** | | | | |
| Diphyllobothriasis, fish tapeworm infection, dibothriocephalus anemia. | *Diphyllobothrium latum* (tapeworm) | Frequently asymptomatic. Intestinal manifestations: abdominal pain and discomfort digestive disorders, loss of appetite, nausea, vomiting. Extraintestinal manifestations: nervous disturbances, weakness, weight loss. | Intestinal obstruction, eosinophilia, toxemia, malnutrition, vitamin $B_{12}$ deficiency, pernicious anemia. | Niclosamide, Quinacrine hydrochloride. |
| Sparganosis. | *Spirometra* spp. (tapeworm larva) | Localized pain in surrounding tissues, urticaria; erythema; chills and fever; | Inflammatory edema and necrosis of adjacent tissues; conjunctivitis; ocular inflammation, eosinophilia. | Surgical removal of plerocercoid larva. |
| **TREMATODE INFECTIONS** | | | | |
| Opisthorchiasis. | *Opisthorchis* spp. (flukes) | Indigestion, epigastric discomfort, weakness; loss of weight, anemia; liver enlarged and tender; diarrhea. | Mechanical and toxic irritations, destruction of hepatic parenchyma, liver dysfunction, jaundice, adenomatous proliferation of tissue cells; liver cirrhosis. | Chloroquine phosphate (inhibits egg production), Chemotherapy not satisfactory in heavy infections. |
| Heterophyasis. | *Heterophyes heterophyes* (fluke) | Usually mild symptoms. In heavy infections: abdominal pain, diarrhea. | In heavy infections: necrosis of intestinal mucosa; eosinophilia; egg embolis of heart or brain with varied tissue reactions. | Tetrachlorethylene; bephenium-hydroxynaphthoate. |
| Metagonimiasis. | *Metagonimus yokogawai* (fluke) | Similar to *H. heterophyes*. In heavy infection; abdominal discomfort, diarrhea. | Occassionally eggs may enter lymphatics or mesenteric venules causing granulomatous lesions in heart and nervous system. | Tetrachlorethylene; bephenium-hydroxynaphthoate. |
| Dicrocoeliasis. | *Dicrocoelium dentriticum* (fluke) | Digestive disturbances, flatulence; vomiting, biliary colic; epigastric pain; chronic constipation or diarrhea. | Inflammation of biliary epithelium; biliary dysfunction, edema, toxemia. | Chloroquine or Dehydroemetine. |
| Paragonimiasis pulmonary distomiasis. | *Paragonimus westermani* (fluke) | Dry cough (early), pulmonary pain; rusty brown sputum (hemoptysis); low-grade fever. | Eosinophilia, fibrous tissue capsule, pleurisy, pneumonitis; | Bithonol, chloroquine-phosphate. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| **TREMATODE INFECTIONS** | | | | |
| Fascioliasis, liver rot. | *Fasciola hepatica* (fluke) | Multiplicity of symptoms. Acute stage; headache, chills, fever, urticaria, tender liver. Chronic stage; substernal pain, digestive disturbances, enlarged liver, jaundice. | Eosinophilia; anemia (0.2 ml blood loss per worm per day), biliary obstruction, metabolic toxicity, adenomatous and fibrotic changes, parenchymal atrophy, cirrhosis (periportal). | Bithinol, dehydroemetine dihydrochloride. |
| Fasciolopsiasis. | *Fasciolopsis buski* (fluke) | Epigastric pain, nausea, vomiting, diarrhea. | Local inflammation, ulceration and abscesses; generalized massive edema obstruction; eosinophilia up to 35%. | Tetrachlorethylene; Hexylresorcinol. |
| Amphistomiasis. | *Gastrodiscoides hominis* (fluke) | Mild irritations, diarrhea. | Mucosal inflammation of cecum and ascending colon. | Tetrachlorethylene. |
| Echinostomiasis. | *Echinostoma* spp. (fluke) | Generally, no significant symptoms. Occassional abdominal pain and diarrhea. | Heavy infections induce catarrhal inflammation. | Tetrachlorethylene. |
| Schistosomiasis, Intestinal bilharziasis, Schistosomal dysentery. | *Schistosoma mansoni* (blood fluke) | Skin penetration--initial signs: itching ("swimmers itch"), rash. Intestinal manifestations; abdominal discomfort, diarrhea, occult blood. Chronic disease: varied symptoms, weight loss, lack of appetite, chills, fever, sweating, liver and spleen tenderness. | Initial phase: transient pruritis, toxemia, eosinophilia. Infiltration of vital organs: hemorrhages, anemia (hypochromic) hepatomegaly, liver cirrhosis, splenomegaly, cellular infiltration; fibrous tissue proliferation; ulcerations. | Antimonials except in hepatic disease, Potassium or sodium antimony tartrate, Stibophen. |
| Oriental schistosomiasis, Katayama disease. | *Schistosoma japonicum* (blood fluke) | Skin penetration: dermatitis Intestinal manifestations: abdominal discomfort, diarrhea, occult blood. Chronic disease: varied symptoms, weight loss, anemia, liver and spleen involvement, neurological and pulmonary symptoms from invading eggs. | Initial phase: transient pruritis, toxic and allergic reactions, subcutaneous edema, eosinophilia Infiltration of vital organs: eggs, severe lesions (more severe than with *S. mansoni*), liver fibrosis, splenomegaly, systemic involvement (embolic eggs), cellular infiltration, ulcerations. | Antimonials, Potassium antimony tartrate. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| CESTODE INFECTIONS | | | | |
| Vesical schistosomiasis, urinary bilharziasis, Schistosomal hematuria. | Schistosoma haematobium (blood fluke) | Skin penetration: itching, suprapubic-urinary signs: pain, painful micturition. Chronic disease: temperature, varied symptoms. | Toxic irritations, eosinophilia, tissue changes, lesions of urinary bladder and genitalia; cystitis; occlusions (ureters, urethra), hematuria. | Niridazole, Antimony sodium dimercaptosuccinate, Stibophen. |
| Schistosome dermatitis, Swimmer's itch, Clam digger's itch. | Schistosoma spp. Trichobilharzia spp. Microbilharzia spp. (larva of avian blood flukes) | Skin irritation, severe itching. | Urticaria, acute inflammation in epithelial layers. Secondary bacterial infection. | Antipruritic and antihistaminic lotions. |
| NEMATODE INFECTIONS | | | | |
| Enterobiasis, Pinworm infection. | Enterobius vermicularis (roundworm) | Perianal irritation, itching abdominal discomfort, weight loss. | Slight eosinophilia (4-12 percent); secondary infections. | Pyrantel pamoate, Piperazine citrate, or Pyrvinium pamoate. |
| Ascariasis, Roundworm infection. | Ascaris lumbricoides (roundworm) | Frequently asymptomatic. Intestinal manifestations: loss of appetite, abdominal pain and discomfort, nausea and vomiting, diarrhea or constipation, loss of weight. | Enteritis-inflammation, obstruction; toxicity, eosinophilia, hemorrhage, trauma by penetrating adults. | Piperazine citrate, Pyrantel pamoate. |
| Visceral larval migrans. | Ascaris spp. Toxocara (roundworm larva) | Intermittent abdominal pain, chest pains; pain associated with other varied sites, fever, nausea and vomiting. | Granulomatous lesions of liver, lungs and other organs; Eosinophilia; anemia; hepatomegaly; pneumonitis; dermatitis, neurologic disturbances, tumors of the eyes, spinal cord and heart in severe cases. | Corticosteroids (prednisone), diethylcarbamazine or thiabendazole. |
| Trichuriasis, Whipworm infection. | Trichuris trichiura (roundworm) | Frequently asymptomatic. But headache, fever, abdominal pain, nausea, vomiting, blood streaked diarrheic stools, and weight loss may occur in heavy infections. | Eosinophilia, severe anemia, hemorrhage, rectal prolapse in extreme cases. | Mebendazole, thiabendazole or dithiazanine enema or hexylresorsinal. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| **NEMATODE INFECTIONS** | | | | |
| Hookworm infection, Ancylostomiasis, Necatoriasis, Unicinariasis. | Ancylostoma duodenale Necator americanus (roundworms) | At site of penetration: "ground itch," sensitization Intestinal manifestations: appetite (enormous or poor), nausea, vomiting, diarrhea or constipation, bloody stools. Extraintestinal manifestations: weakness, dizziness, pulmonary distress, allergic symptoms. | Anemia (chronic nutritional deficiency type), eosinophilia, erythema, dyspnea, bronchitis, pneumonitis. | Pyrantel pamoate; Tetrachlorethylene; or Thiabendazole; Bephenium hydroxynaphthoate when Ascaris is also present. |
| Cutaneous larval migrans, Creeping eruption. | Ancylostoma braziliense other Ancylostoma Other Hookworm species (roundworm larva) | Itching: intense irritation of the skin at the site of entry of larvae; other skin complications. | Eosinophilia; cellular infiltration, reddish serpiginous intracutaneous tunnels, secondary bacterial infections. | Thiabendazole Freezing ectopically with chloride or carbon dioxide snow. |
| Strongyloidiasis, Cochin China dysentery. | Strongyloides stercoralis (roundworm) | Often asymptomatic: Gastrointestinal manifestations: midepigastric pain, nausea, vomiting, diarrhea or constipation, chronic dysentery. Extraintestinal manifestations: weight loss, low-grade fever. | Chronic gastrointestinal inflammation, eosinophilia, anemia, secondary bacterial infections, biliary and pancreatic inflammation. | Thiabendazole; Pyrvinium pamoate. |
| Trichostrongyliasis. | Trichostrongylus species (roundworm) | Usually asymptomatic: vague abdominal disturbances in heavy infections. | In heavy infections: inflammation of the intestinal mucosa and gallbladder, secondary anemia, transient eosinophilia. | Thiabendazole; Pyrantel pamoate. |
| Capillariasis. | Capillaria hepatica Capillaria Philippinensis (roundworm) | Diarrhea, weakness, abdominal distention and pain, malabsorption. | Inflammation of the liver (C. hepatica) and intestine (C. philippinensis), tissue destruction, cardiac abnormalities. | Thiabendazole. Mebendazole. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| **NEMATODE INFECTIONS** | | | | |
| Trichinosis. Trichinelliasis. | *Trichinella spiralis* (roundworm larva and adults) | Varied pain and tenderness of muscles and joints; headache, fever, nausea, vomiting, diarrhea, edema, weakness; involvement of eye, heart, respiratory system, and central nervous system cause many varied symptoms. | Larval invasion of striated muscle and vital organs, eosinophilia, acute interstitial inflammation, pneumonitis, pleurisy, encephalitis, meningitis, nephritis, deafness, peritonitis, eye and brain trauma, myocarditis. | No effective chemotherapy; rest, fluids, Salycilates relieve muscle symptoms; Thiabendazole. |
| Bancroftian filariasis. Wuchereriasis elephantiasis. | *Wuchereria bancrofti* (blood and tissue roundworm) | Asymptomatic (early infection); Enlargement of lymph nodes. Acute stage: fever, chills, head ache, vomiting; general malaise, Systemic allergic symptoms. Obstructive disease: enlargement of affected body regions usually as a result of repeated infections with fever and pain. | Eosinophilia; epididymitis; orchitis; lymphangitis; Abscesses of pelvis, kidney, scrotum, inguinal nodes and varied tissues from dead worms. Acute granulomatous inflammation in lymphatics due to worms and by products; lymphedema and lymphangitis of the genitalia, breast or extremities resulting in elephantiasis. | Diethylcarbamazine |
| Malayan filariasis. | *Brugia malayai* (blood and tissue roundworm) | Asymptomatic carriers; enlargement of lymph nodes and affected body regions much like *W. bancrofti*. | Eosinophilia; lymphangitis and elephantiasis as with *W. bancrofti*. | Diethylcarbamazine |
| Loasis, eyeworm infection, calabar. | *Loa, loa* (blood and tissue roundworm) | Migration through subcutaneous tissues and orbital conjunctiva causing irritation, pain and impaired vision; Calabar swellings. | Eosinophilia, edema, pruritis, dermatitis; abscesses from secondary pyogenic infections. | Diethylcarbamazine; surgical removal of adult. |
| Onchocerciasis. | *Onchocerca volvulus* (blood and tissue roundworm) | Filarial itch; thick wrinkled skin; dizziness; many varied symptoms by adult worms and trapped microfilaria eventually cause blindness; disfigurement and discoloration of the skin. | Eosinophilia; lesions of the subcutaneous tissues, skin and eyes; fibrous infiltration of host cells forming a capsule or nodule; hanging groin; elephantiasis; interference with Vitamin A metabolism. | Diethylcarbamazine plus suramin; Surgical removal of encapsulated adults. |

| DISEASE | CAUSATIVE AGENT | SYMPTOMATOLOGY | PATHOLOGY | TREATMENT |
|---|---|---|---|---|
| NEMATODE INFECTIONS | | | | |
| Mansonelliasis. Ozzard's filariasis. | Mansonella ozzardi (blood and tissue roundworm) | Symptoms vague; not remarkable, Slight enlargement of lymph nodes. | Slight damage to peritoneal connective tissue. | Diethylcarbamazine. |
| Mansonelliasis, dipetalonemiasis acanthocheilonemiasis. | Mansonella perstans (blood and tissue roundworm) | Minor allergic phenomena, Slight enlargement of lymph nodes. | Edema, calabar swellings. | Diethylcarbamazine. |
| Mansonelliasis, dipetalonemiasis. | Mansonella streptocerca (blood and tissue roundworm) | Wrinkling of the skin, itching. | Cutaneous edema. | Diethylcarbamazine. |
| Dirofilariasis | Dirofilaria immitus (blood and tissue round worm) | Cough, chest pain. | Infarcted lung lesions; nodules in various sites. | Diethylcarbamazine, Surgical removal. |
| Dracunculiasis, dracontiasis. | Dracunculus medinensis (tissue roundworm) | Urticaria, erythema, dyspnea, vomiting, pruritis. | Eosinophilia, subcutaneous blisters, edema, abscesses, extensive ulceration, necrosis. | Removal of adult (Xray to Locate). Thiabendazole. Niridazole. |
| ACANTHOCEPHALID INFECTIONS | | | | |
| Acanthocephalitis, acanthocephaliasis. | Macracanthorhynchus hirudinaceus (Thorny-headed roundworm) | Vague abdominal cramps. | Inflammation of the intestinal mucosa. | Oleoresin of aspidium, Mebendazple (children). |

**End of Appendix A**

## APPENDIX B

## REFERENCES

This subcourse can provide you with a basic background/review of parasitology. During your study of the subcourse, you may identify topics which greatly interest you or pertain especially to your job. In these cases, you may wish to perform an indepth study on that topic on your own.

This APPENDIX is a listing of references which might prove useful to you as you begin these learning efforts. You must evaluate each reference in terms of the level it is written, the amount of technical language it uses, and the recency of information it contains.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**End of Appendix B**

# APPENDIX C

## MEDICAL PARASITOLOGY

Color Plates - Plasmodium species

Table of Contents

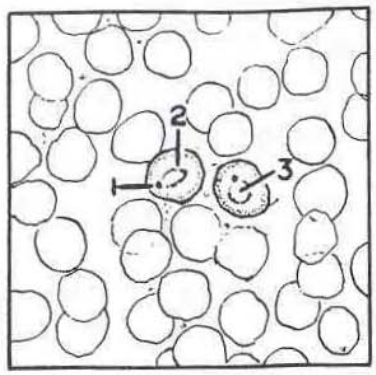
Plasmodium vivax.

Plasmodium ovale.

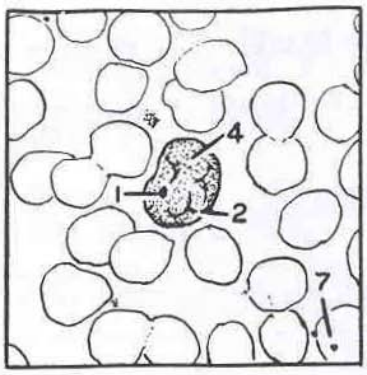
Plasmodium malariae.

Plasmodium falciparum.

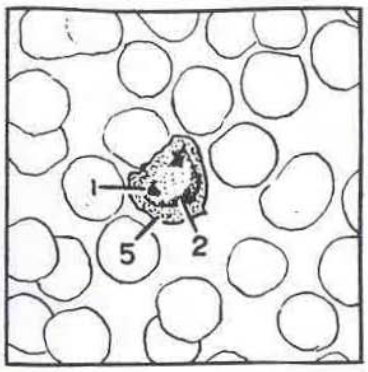
# PLASMODIUM VIVAX
PLATE 1



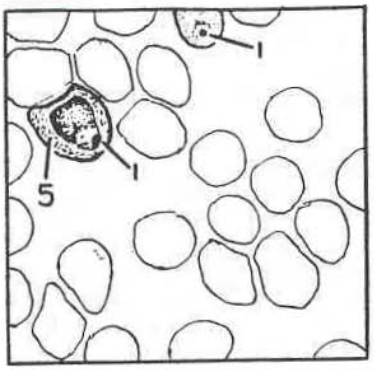
1–1 ring forms



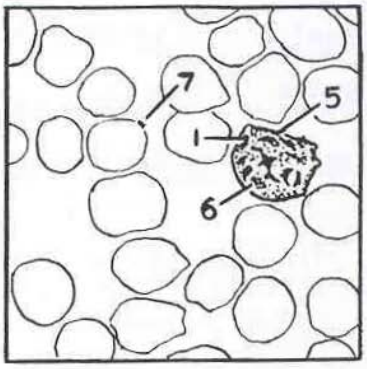
1–2 amoeboid trophozoite



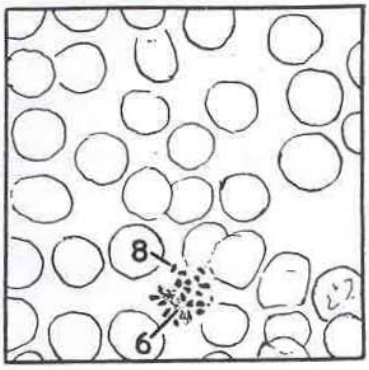
1–3 growing trophozoite



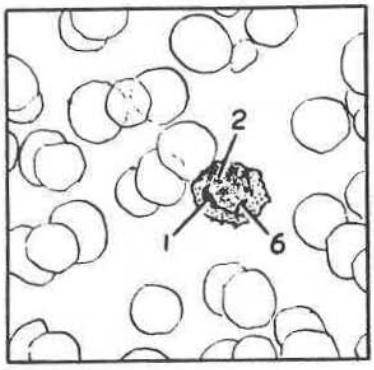
1–4 mature trophozoite



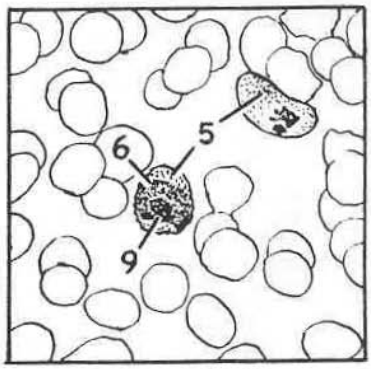
1–5 immature schizont



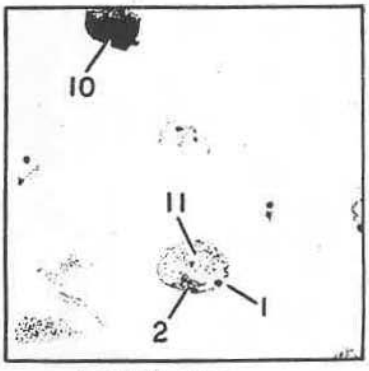
1–6 mature schizont



1–7 macrogametocyte



1–8 microgametocyte

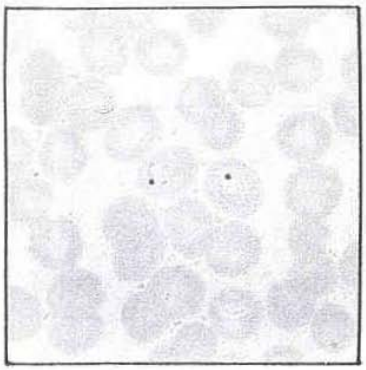


1–9 thick smear

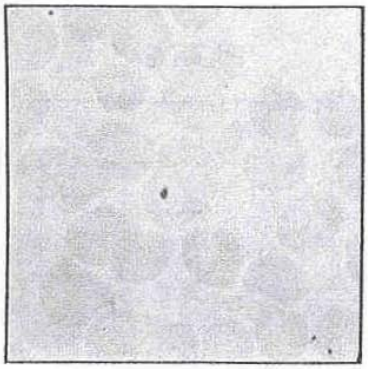
LEGEND

1. nuclear chromatin (condensed)
2. cytoplasm of parasite (ameboid)
3. vacuole
4. enlarged RBC (pale)
5. Schuffner's granules
6. henozoin pigment
7. artifact
8. merozoites (17)
9. diffused chromatin
10. nucleus of WBC
11. ghost of RBC (Schuffner's)

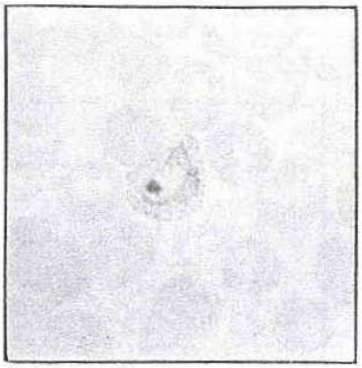
# PLASMODIUM VIVAX
PLATE 1



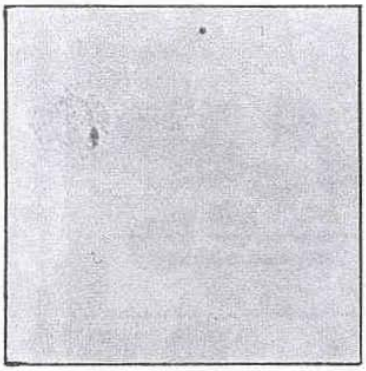
1–1 ring forms



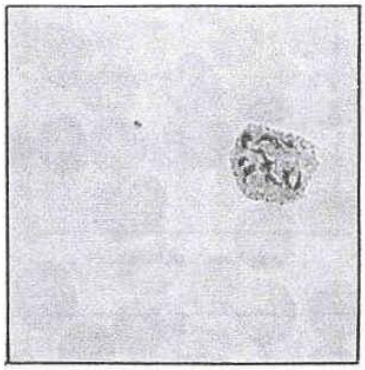
1–2 amoeboid trophozoite



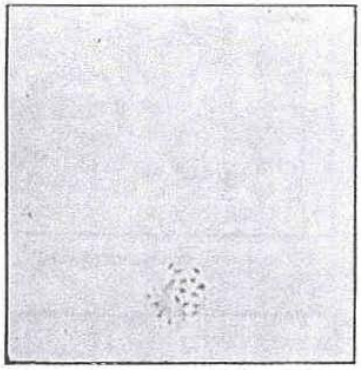
1–3 growing trophozoite



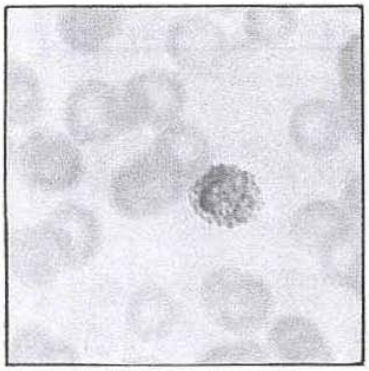
1–4 mature trophozoite



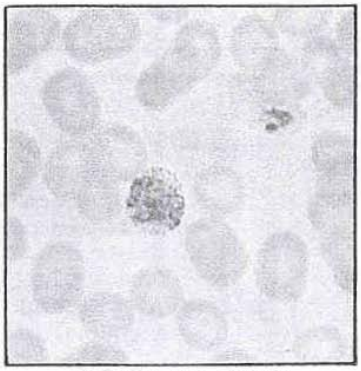
1–5 immature schizont



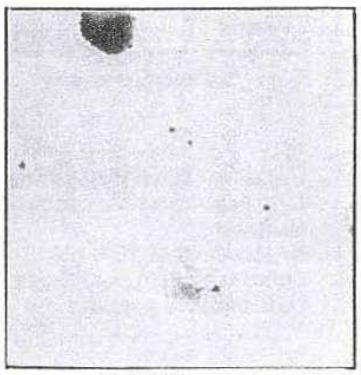
1–6 mature schizont



1–7 macrogametocyte

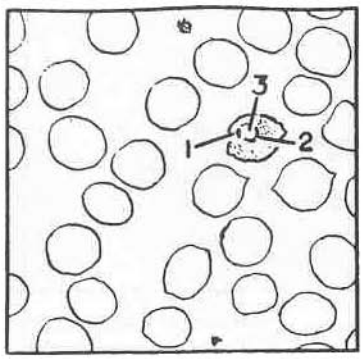


1–8 microgametocyte

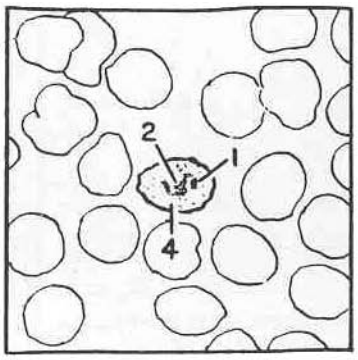


1–9 thick smear

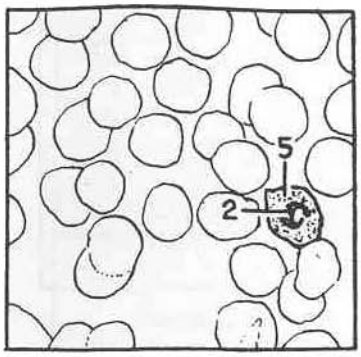
# PLASMODIUM OVALE
PLATE 2



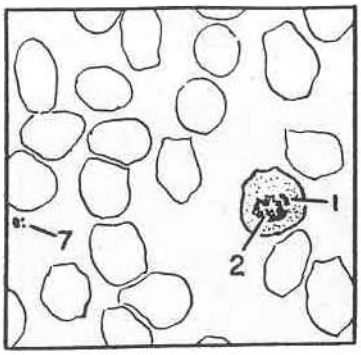
2-1 ring form



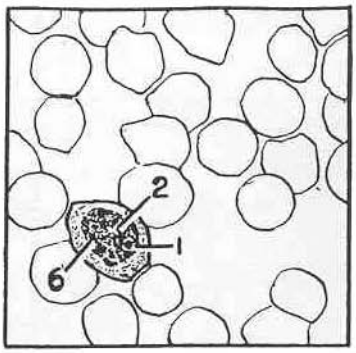
2-2 growing trophozoite



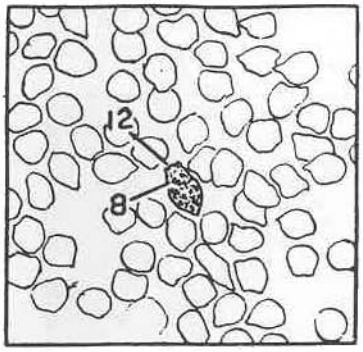
2-3 growing trophozoite



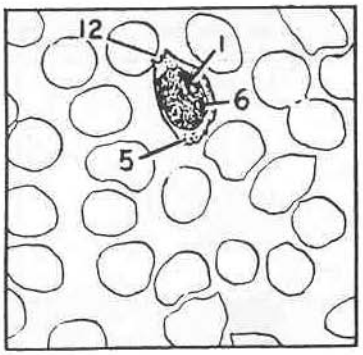
2-4 mature trophozoite



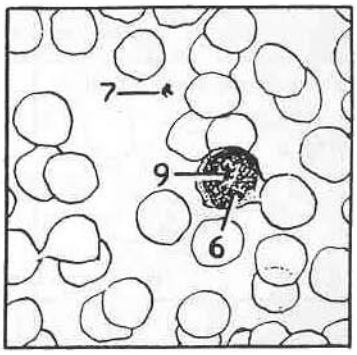
2-5 immature schizont



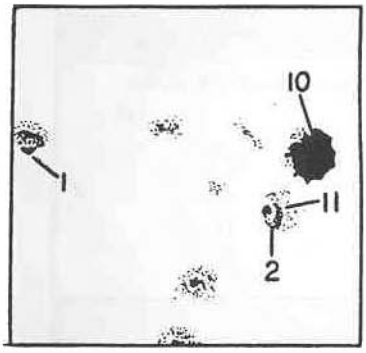
2-6 mature schizont



2-7 macrogametocyte



2-8 microgametocyte

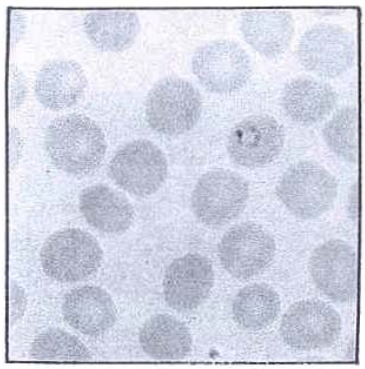


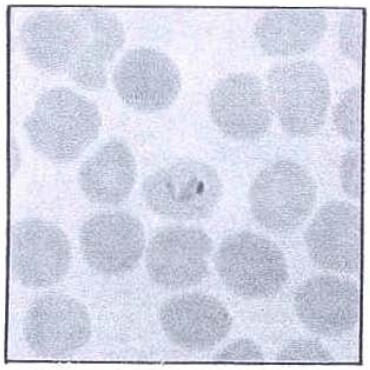
2-9 thick smear

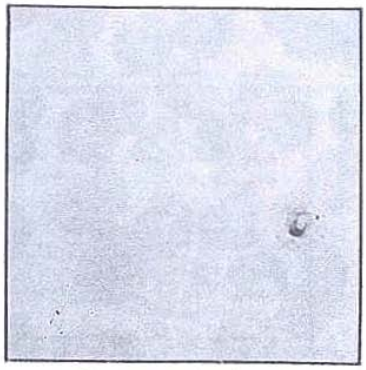
LEGEND

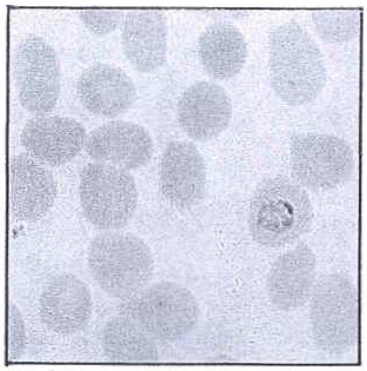
1. nuclear chromatin (condensed)
2. cytoplasm of parasite (compact)
3. vacuole
4. typical oval RBC
5. Schuffner's granules (course)
6. henozoin pigment
7. platelets
8. merozoites (8)
9. diffused chromatin
10. nucleus of WBC
11. ghost of RBC (Schuffner's)
12. fimbriation

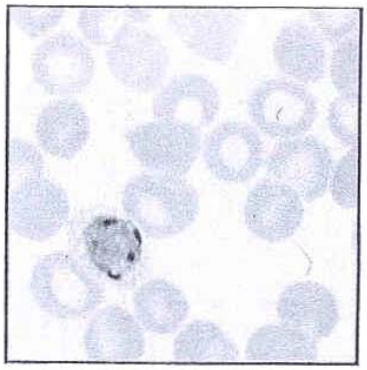
# PLASMODIUM OVALE
PLATE 2

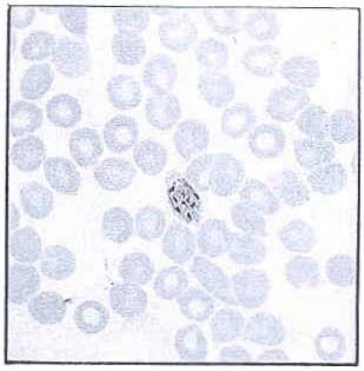

2–1 ring form

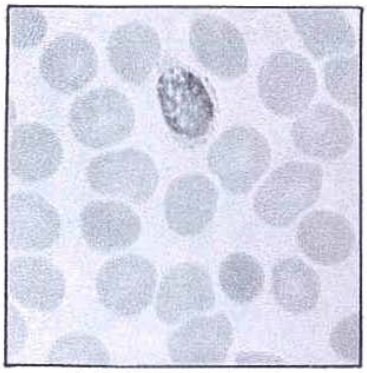

2–2 growing trophozoite

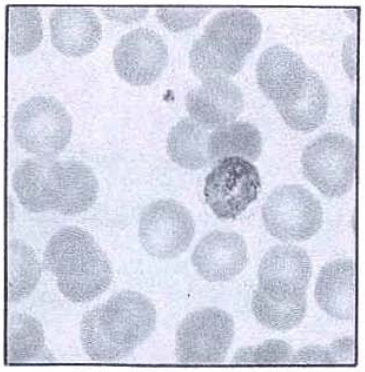

2–3 growing trophozoite

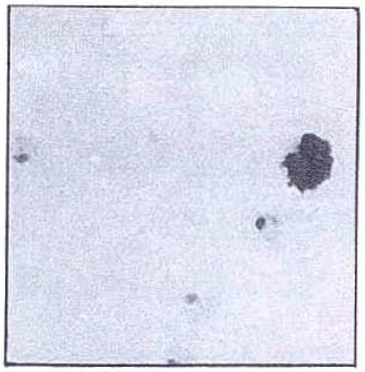

2–4 mature trophozoite


2–5 immature schizont

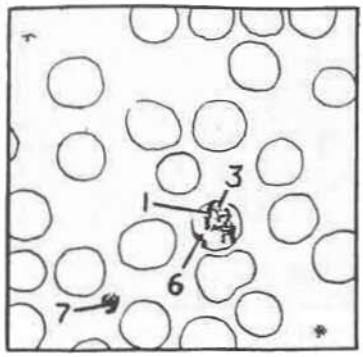

2–6 mature schizont


2–7 macrogametocyte

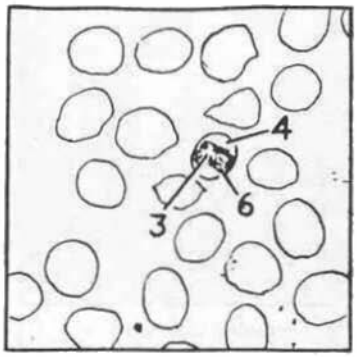

2–8 microgametocyte


2–9 thick smear

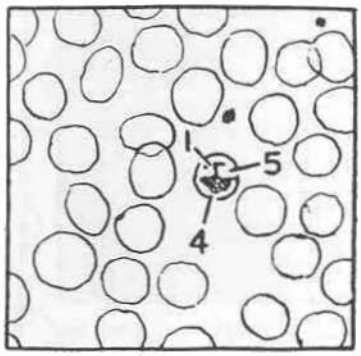
# PLASMODIUM MALARIAE
PLATE 3



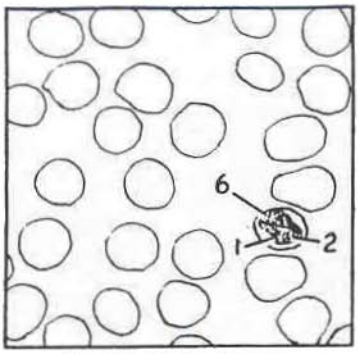
3-1 growing trophozoite



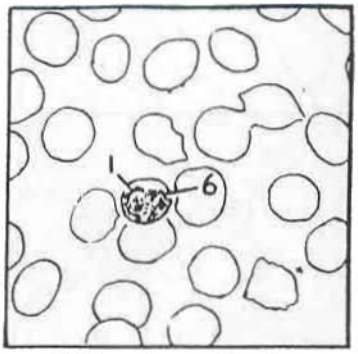
3-2 band form



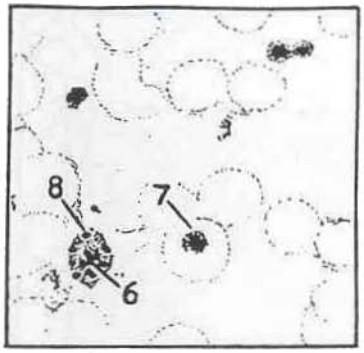
3-3 basket form



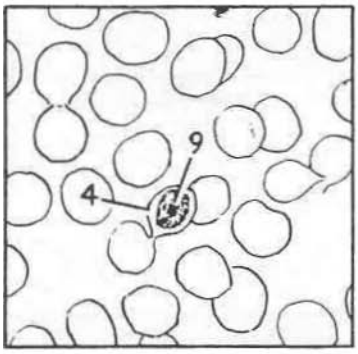
3-4 mature trophozoite



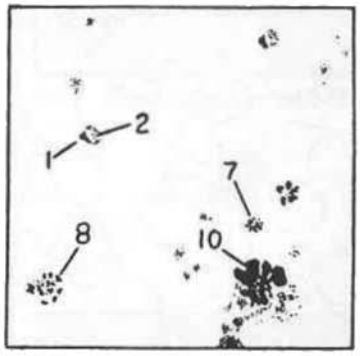
3-5 immature schizont



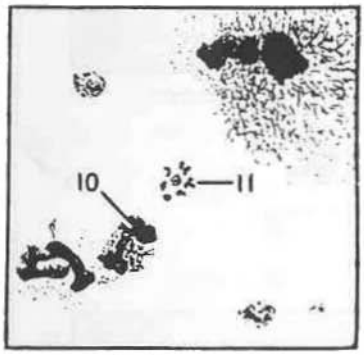
3-6 mature schizont



3-7 microgametocyte



3-8 thick smear

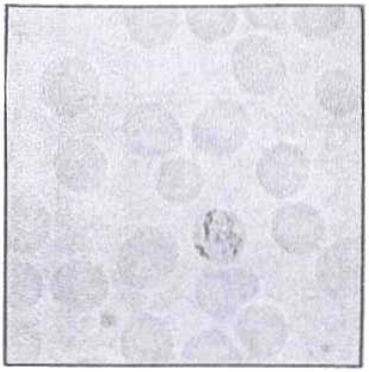


3-9 thick smear

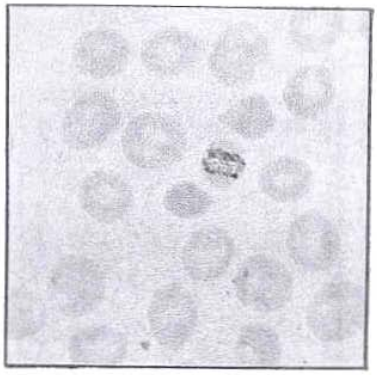
LEGEND

1. nuclear chromatin
2. cytoplasm of parasite (compact)
3. vacuole indistinct
4. infected RBC (microcytic)
5. RBC normal palor
6. henozoin pigment (dark)
7. platelets
8. merozoites (8-10)
9. diffused chromatin
10. nucleus of WBC
11. schizont (rosette arrangement)

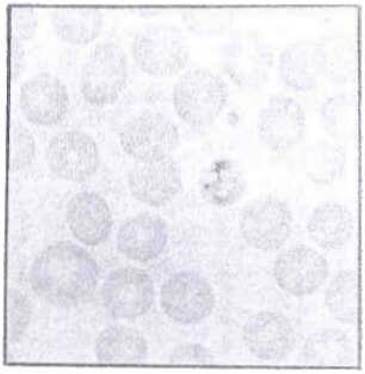
# PLASMODIUM MALARIAE
PLATE 3



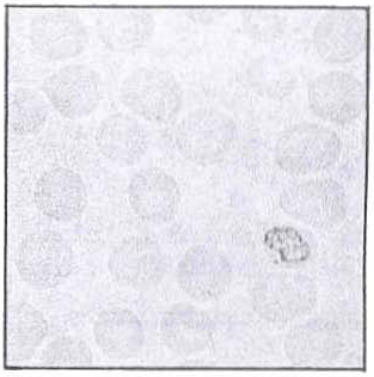
3–1 growing trophozoite



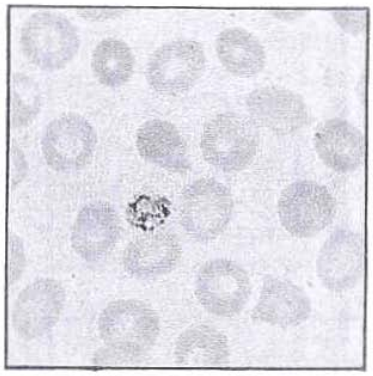
3–2 band form



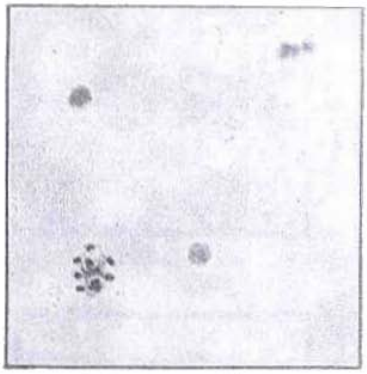
3–3 basket form



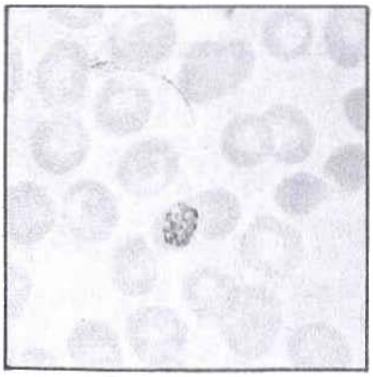
3–4 mature trophozoite



3–5 immature schizont



3–6 mature schizont



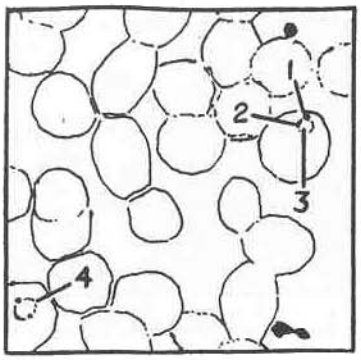
3–7 microgametocyte

3–8 thick smear

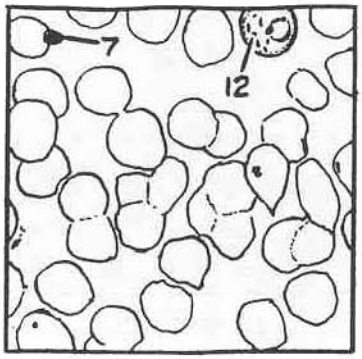
3–9 thick smear

# PLASMODIUM FALCIPARUM

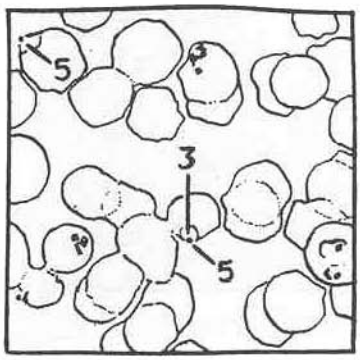
PLATE 4



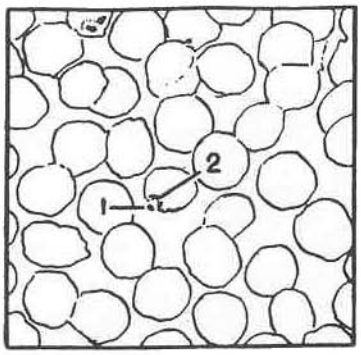

4–1 ring forms



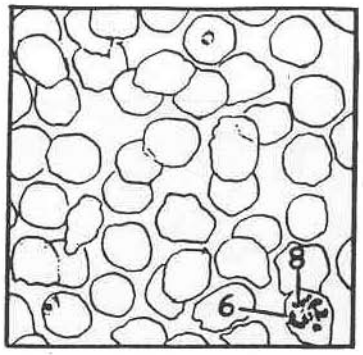

4–2 older ring forms



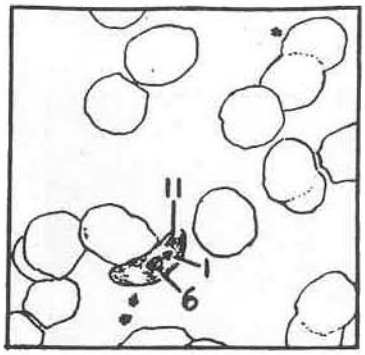

4–3 many ring forms



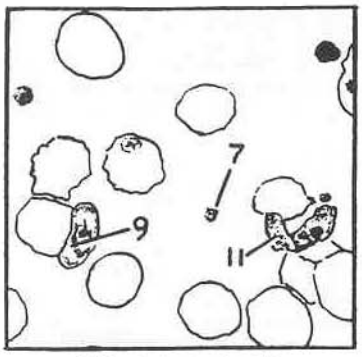

4–4 trophozoites



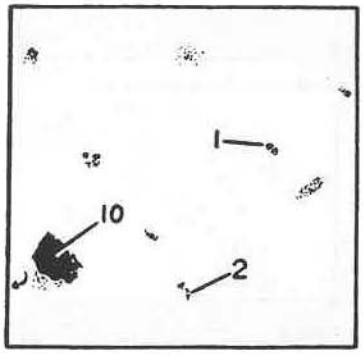

4–5 immature schizont



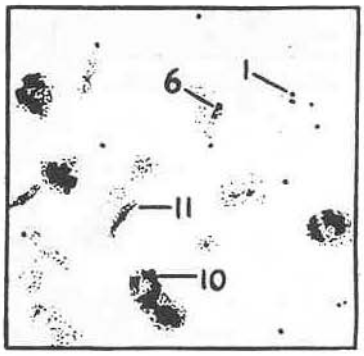

4–6 macrogametocyte




4–7 microgametocyte




4–8 thick smear



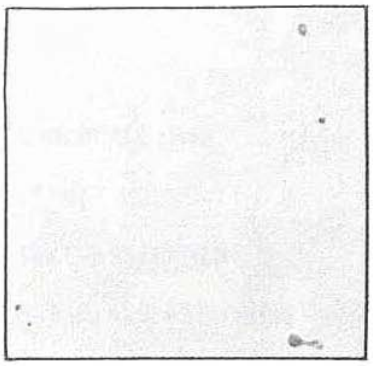

4–9 thick smear

LEGEND

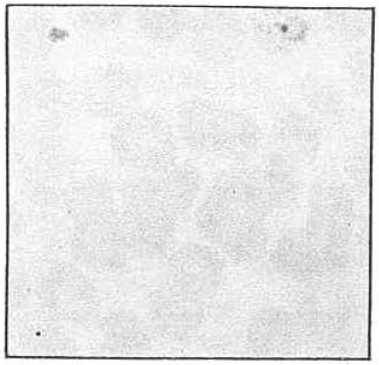
1. nuclear chromatin ((small)
2. cytoplasm of parasite (delicate)
3. vacuole
4. double signet ring
5. applique or accole' form
6. henozoin pigment (dark)
7. platelet
8. merozoites (8-32)
9. diffused chromatin
10. nucleus of WBC
11. cresentic shape (diagnostic)
12. Maurer's clefts

## PLASMODIUM FALCIPARUM

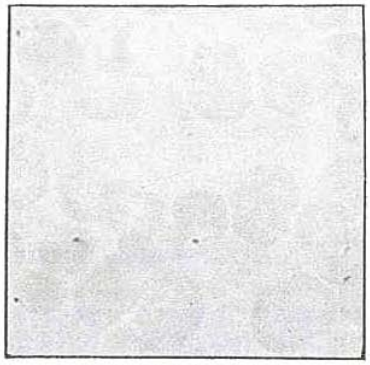
PLATE 4



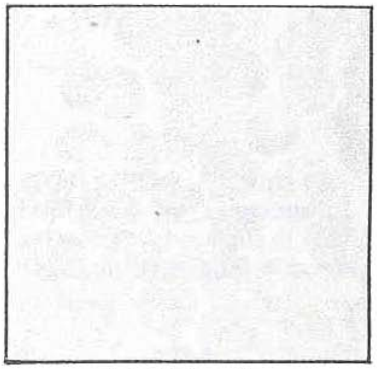
4–1 ring forms



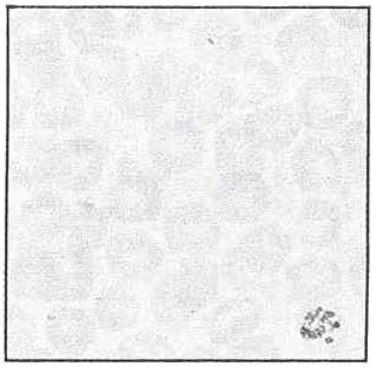
4–2 older ring forms



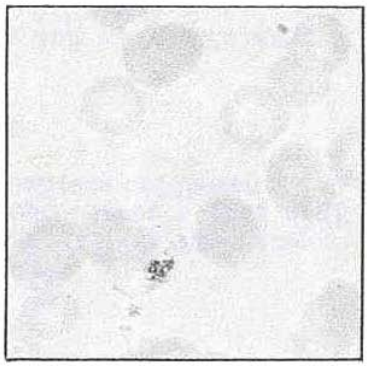
4–3 many ring forms



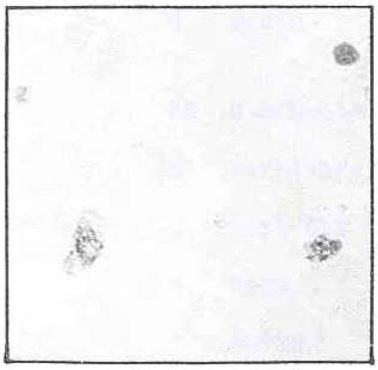
4–4 trophozoites



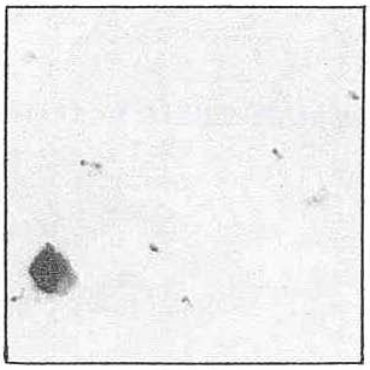
4–5 immature schizont



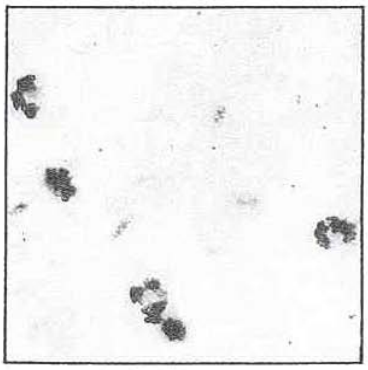
4–6 macrogametocyte



4–7 microgametocyte



4–8 thick smear



4–9 thick smear

**End of Appendix C**